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AN 16-30APN9-3

HANDBOOK OF
MAINTENANCE INSTRUCTIONS

for

RADAR SET
AN/APN-9

RESTRICTED
(For Official Use Only)

*Published under joint authority of the United States War and Navy
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AN 16-30APN9-3

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SAFETY NOTICE

This equipment employs high voltages which are dangerous and may be fatal if contacted by personnel. Use extreme caution when working with the equipment.

SECTION I GENERAL DESCRIPTION

1. GENERAL.

(See figure 1-2.)

a. Radar Set AN/APN-9 is an airborne navigation equipment composed of Receiver-Indicator R-65/APN-9, equipped with a detachable visor, the necessary cables, and an antenna switch (not shown). It is mounted on a shock mounting (Mounting Bracket FT-446 or MT-203/APN). The equipment operates on the LORAN principle. It receives, amplifies, and detects LORAN signals and displays them on the screen of a cathode-ray indicator tube in the receiver-indicator.

b. Radar Set AN/APN-9 will operate at any altitude

between sea level and 40,000 feet. It is designed to operate satisfactorily within a temperature range of -55°C (-67°F) to $+50^{\circ}\text{C}$ ($+122^{\circ}\text{F}$).

c. The power supply frequency is between 400 and 2400 cycles per second. The nominal power supply voltages are 80 and 115 volts, selected by the connections of the power connector plug (see figure 6-3). The power consumption is 190 volt amperes when the "RECEIVER GAIN" control is adjusted for maximum gain.

2. EQUIPMENT SUPPLIED.

The following equipment is supplied with Radar Set AN/APN-9.

EQUIPMENT SUPPLIED

Quantity per Equipment	Name of Unit	Army-Navy Type Designation	British Type Designation	Overall Dimensions (Inches)	Weight (Pounds)
1	Receiver-Indicator including 1 lens, 1 visor, 1 crystal, and a complete tube complement	R-65/APN-9		$9\frac{1}{8} \times 12\frac{1}{16} \times 30\frac{9}{16}$ with visor $9\frac{1}{8} \times 12\frac{1}{16} \times 22\frac{15}{32}$ without visor	36 (max.)
1	Radio Frequency Cable Coaxial Antenna Cable	RG-8/U		40 feet	
1	Coupling for Radio Frequency Cable RG-8/U	MC-277 or MC-277-A	10 H/701	$1.3 \times 0.8 \times 0.7$	0.24
1	Cable Clamp	M-297		$1.25 \times 1.2 \times 0.7$	0.6
1	Plug (for power supply)	PL-166			
1	Mounting Bracket	MT-203/APN or FT-446		$19.5 \times 8.6 \times 2.2$	2.3

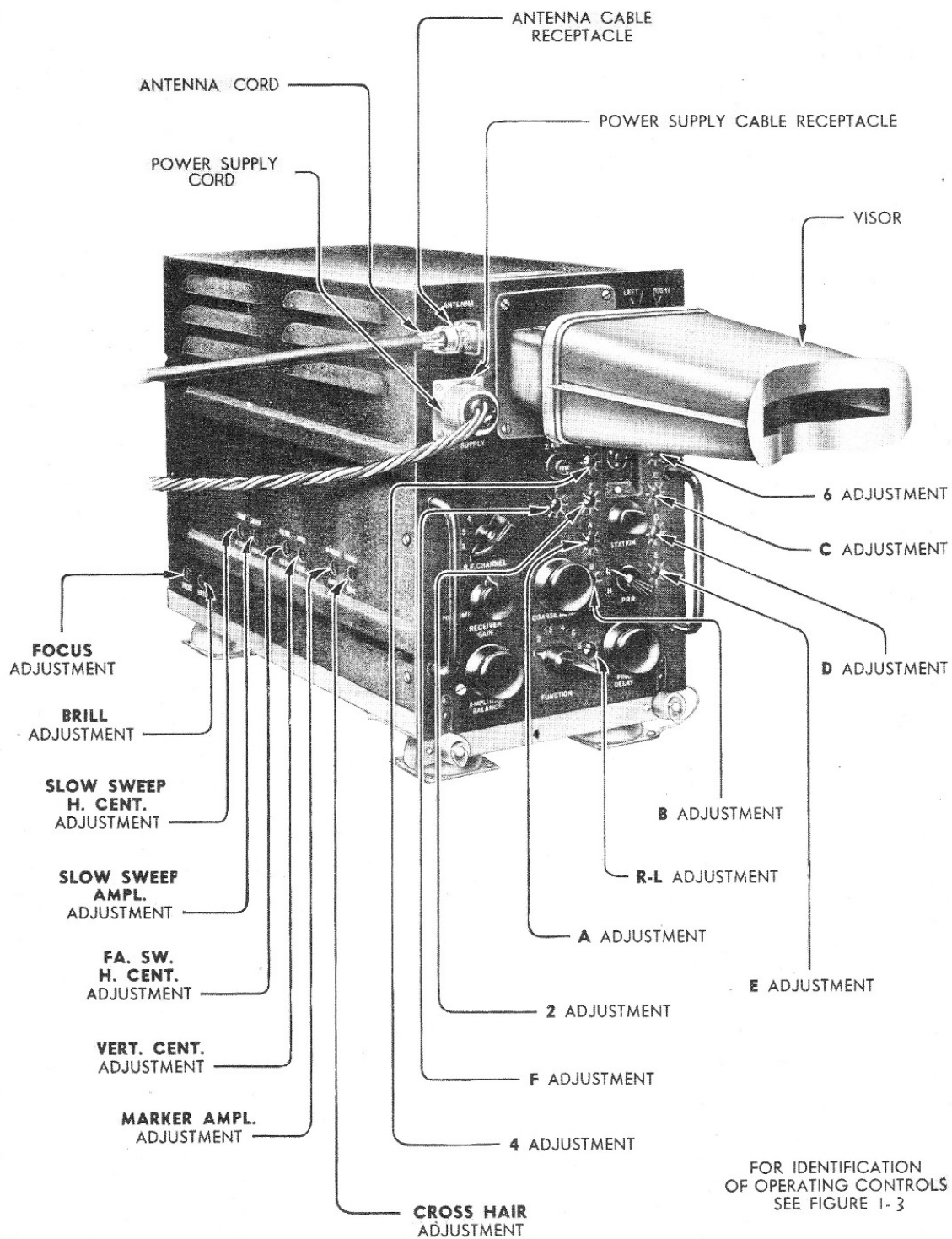


Figure 1-2. Receiver-Indicator R-65/APN-9—Exterior View, Left Side

3. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

a. The installation equipment required for the operation of the Receiver-Indicator R-65/APN-9 but not supplied with it is listed below:

Quantity per Equipment	Name of Unit	Army Type Designation	Navy Type Designation	Required Characteristics
1	Power Unit			Capable of supplying 80 or 115 volts at 400 to 2400 cycles per second and 190 volt amperes.
1	Antenna			Trailing wire or fixed
1	*Switch or Antenna Switch	SA-13/U or SW-225		DPDT or TPDT

*In airplanes where no trailing wire antenna exists, Coupler CU-921/APN is installed in place of a switch to permit simultaneous Loran and liaison set operation from a single fixed antenna.

b. Test equipment required with Radar Set AN/APN-9 is listed below:

Quantity per Equipment	Name of Unit	Army Type Designation	Navy Type Designation	Required Characteristics
		CLASS A TEST EQUIPMENT		
1	Voltmeter	IS-189		
1	Test Set	I-56K		
1	Test Set	TS-251/UP		Pulse generator attenuator
		CLASS B TEST EQUIPMENT		
1	Oscilloscope	RCA #158	Dumont 241	Standard
1	Signal Generator	I-72		Frequency coverage ranging from 1100 kilocycles to 2000 kilocycles.
1	Frequency Meter	SCR-211	LM-13	Standard

4. DESCRIPTION OF RECEIVER-INDICATOR R-65/APN-9.

(See figure 1-2.)

Radar Set AN/APN-9 is composed of a receiver-indicator, with a detachable visor, cables, cable connectors, and an antenna switch (not shown) as listed in paragraph 2, this section. In addition, the equipment requires provisions for power supply and antenna.

The receiver-indicator is mounted on a shock mount (Mounting Bracket MT-203/APN or FT-446), and is removed or installed by operating the thumb nuts on the front of the shock mount frame.

a. **MANUAL CONTROL LOCATIONS AND MARKINGS.**—The receiver-indicator unit is housed in an aluminum case. The following manual controls are accessible on the front panels: r-f channel switch, marked "R.F. CHANNEL"; receiver gain control, marked "RECEIVER GAIN," (this control also operates the power switch for the equipment and is designated by the marking "POWER OFF"); amplitude balance control marked "AMPLITUDE BALANCE"; a coarse delay control, marked "COARSE DELAY"; a six-position function switch, marked "FUNCTION"; a left-right switch, marked "LEFT-RIGHT"; a crystal frequency control, marked "DRIFT"; a station switch, marked "STATION," which selects one of eight stations (the station numbers "0" to "7" are illuminated with a midjet pilot light); a pulse recurrence rate switch, marked "PRR"; and a fine delay control, marked "FINE DELAY." There are two cable receptacles on the front panel, an antenna connector marked "ANTENNA"; and a power supply connector marked, "POWER

SUPPLY." A fuse holder for the active fuse, marked "2 AMP," and a spare fuse (not marked) located in a clip on the under side of the lensholder are also accessible on the front panel.

b. SCREW DRIVER CONTROLS.

(1) In addition to the manual controls described previously, there are 24 screw driver controls on the receiver-indicator. The 10 on the front panel are marked as follows: "2," "4," "6," and "A," "B," "C," "D," "E," "F," and "R-L."

(2) Six screw driver-adjusted controls are located on the right side of the receiver-indicator as shown in figure 1-3. These are, reading from front to back, one marked "FINE DELAY"; four controls in the "COARSE DELAY" group, marked "H-PRR MIN.," "L-PRR MIN.," "L-PRR MAX.," "H-PRR MAX." and a sixth control marked "FA. SW. AMPL."

(3) Eight screw driver-adjusted controls on the left side of the receiver-indicator are shown in figure 1-2. Reading in sequence from back to front, these are marked as follows: "FOCUS," "BRILL.," "SLOW SWEEP H. CENT.," "SLOW SWEEP AMPL.," "FA. SW. H. CENT.," "VERT. CENT.," "MARKER AMPL.," and "CROSS HAIR."

c. **CIRCUIT BREAKDOWN.**—Figures 1-4 and 1-5 show the receiver-indicator with the dust cover removed. Tubes, transformers, capacitors, and switches make up the five functional circuits of the set: namely, radio receiver, timer, delay and deflection, power supply, and the indicator tube. A magnifying lens is supplied to enlarge the patterns appearing on the cathode-ray tube indicator screen.

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AN 16-30APN9-3

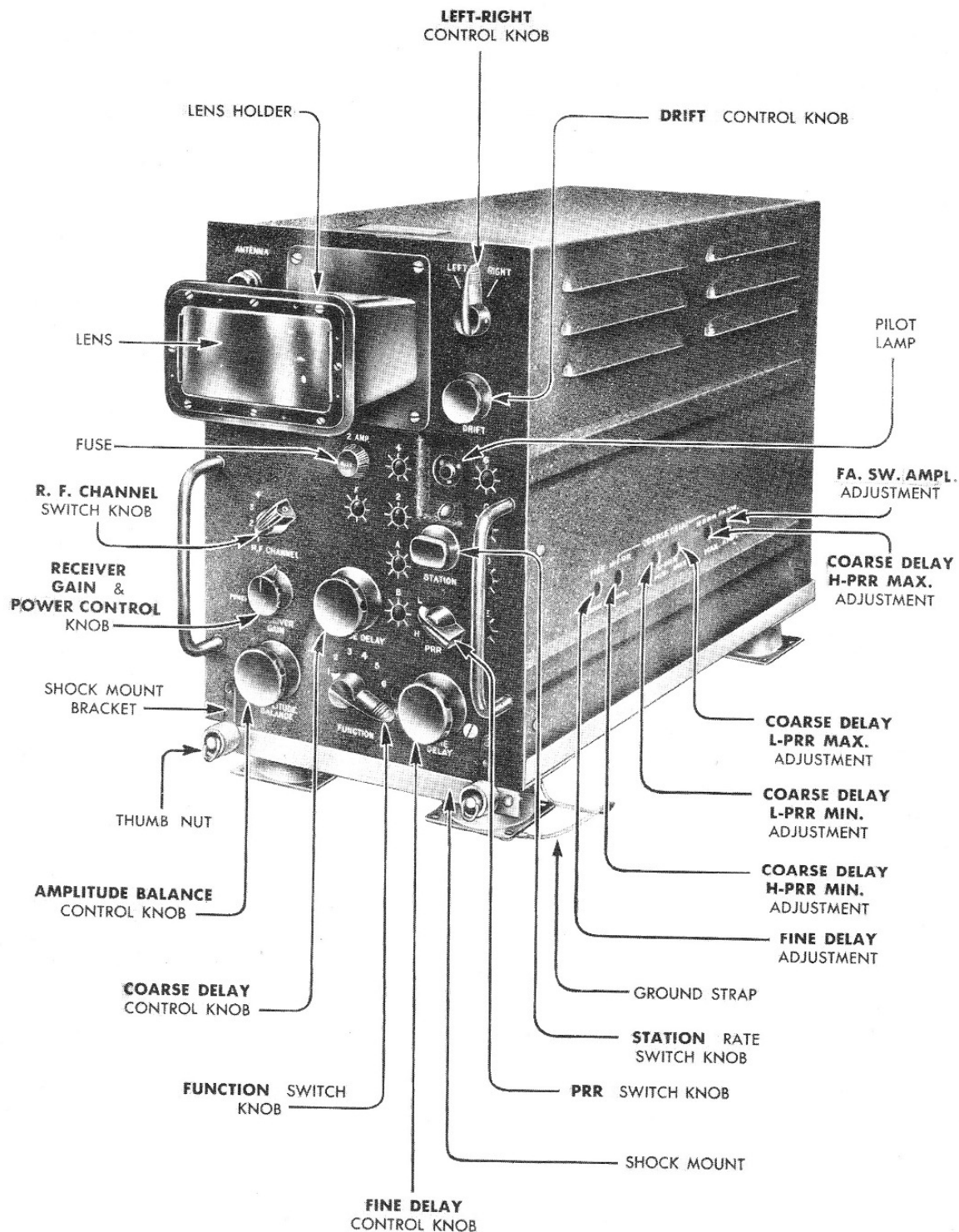


Figure 1-3. Receiver-Indicator R-65/APN-9—Exterior View, Right Side

SECTION II

INSTALLATION AND ADJUSTMENT

1. INSTALLATION.

a. INITIAL PROCEDURE.

(1) Carefully unpack and remove the receiver-indicator and the visor from the packing case.

(2) Inspect for external damage, making certain that the cover is in good condition and free from cracks or dents which might impair its satisfactory operation.

(3) Examine all the control knobs to see that they are held firmly in place by the setscrews and are in good condition.

(4) Inspect the visor for defects or damage which might impair its installation or proper functioning.

b. BENCH TEST.—Refer to section V, paragraph 4.

c. LOCATION OF RECEIVER-INDICATOR.

(1) Install the equipment in a location in the air-plane where free air will circulate around the equipment. The location should also be chosen to minimize temperature changes.

(2) Install the receiver-indicator at a height which will enable the operator, when seated, to command a full clear view of the screen with the visor installed, and to see and manipulate all controls on the front panel. (See figure 6-17.) Sufficient illumination should be provided so that indications on the controls are readily distinguishable to the operator.

(3) Allow sufficient clearance to permit the use of a screwdriver to adjust the controls which are located on the right and left hand sides of the receiver-indicator.

(4) Allow sufficient clearance on all sides, top, and back to permit the receiver-indicator to move or vibrate on the shock mounting without striking fixed objects.

(5) Allow sufficient room so that all wires and cables may be connected to the receiver-indicator without interference from other fixed objects.

d. INSTALLATION OF SHOCK MOUNT.

(1) Install Mounting Bracket MT-203/APN or FT-446 by following the instructions found on figure 6-17.

(2) Use four No. 8 machine screws for each foot to fasten the shock mounting securely to the support provided. Where working space is limited, it may be necessary to install the shock mounting on a piece of plywood cut to the correct size.

(3) Connect the ground strap of the shock mounting securely to the nearest structural member of the air-plane. Make all ground connections to bright metal surfaces which are thoroughly clean and free from paint, dirt, or other substances. (See Army-Navy Aeronautical Specification Bonding; Electrical for Aircraft AN-B-10.)

e. INSTALLATION OF THE RECEIVER-INDICATOR.

(1) Carefully place the receiver-indicator on the shock mounting frame.

(2) Insert the two spring plungers which protude from the back of the receiver-indicator through the holes located at the back of the shock mounting frame.

(3) Tighten the knurled thumb nuts on the front of the shock mounting frame to the two brackets on the front of the receiver-indicator.

(4) Make certain that the receiver-indicator rides securely on the shock mounting and that nothing prevents the shock mounting from functioning correctly.

f. CORDAGE.

(1) POWER CABLE.

(a) Assemble the power supply cable according to the instructions given in figure 6-19.

(b) The cable used will depend upon the air-plane power supply installation. Install a two-wire cable except when a starting relay is used; in that case install a four-wire cable.

(c) The connections of the power leads to the plug will depend upon the voltage of the airplane power supply. (See figure 6-19.)

(d) Use wire No. 18 for the power leads. These leads should preferably be no longer than 10 feet in length between the point of measurement of the line voltage and the power plug.

(e) The leads of the starting relay must be of sufficient capacity to carry the prescribed current safely.

(f) No sharp bends or breaks must appear in the cable assembly and ample slack must always be present to permit quick and easy connection and disconnection, and to prevent impairment of shock mounting.

(2) ANTENNA CONNECTIONS. (See figures 6-19 and 8-30.)

(a) Connect Radio Frequency Cable RG-8/U to the antenna receptacle (color-coded green) of the antenna knife switch, Switch SA-13/U or SW-225.

1. Switch SW-225 (TPDT) is installed when Antenna Tuning Unit BC-306-B is used with the liaison set.

2. Switch SA-13/U (DPDT) is installed when Antenna Tuning Unit BC-306-A is used with the liaison set.

(b) Both switches lead to the liaison set to the trailing wire antenna reel and to the fixed antenna of the airplane.

(c) Connect the receiver end of the cable to Coupling MC-277 on the receiver-indicator.

WARNING

This equipment employs high voltages which are dangerous and may be fatal if contacted by operating personnel. Use extreme caution when working with Receiver-Indicator R-65/APN-9.

2. ADJUSTMENTS.

Before attempting any adjustments, maintenance personnel must be thoroughly familiar with the operation of this equipment as described in section III.

The following procedure is to be adhered to in adjusting Receiver-Indicator R-65/APN-9 after the equipment has been installed in the airplane.

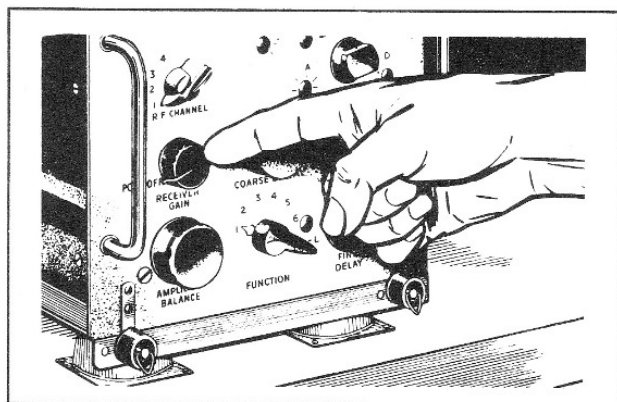


Figure 2-1

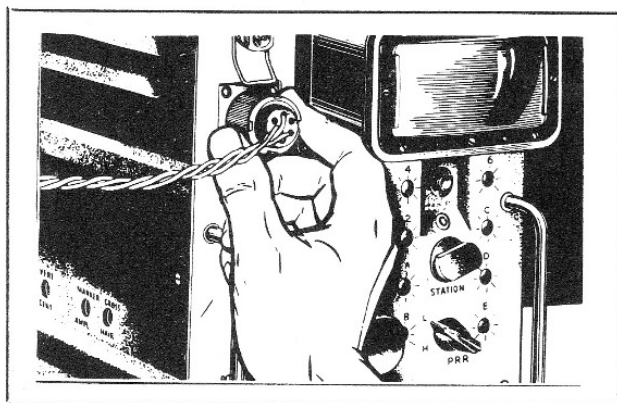


Figure 2-2

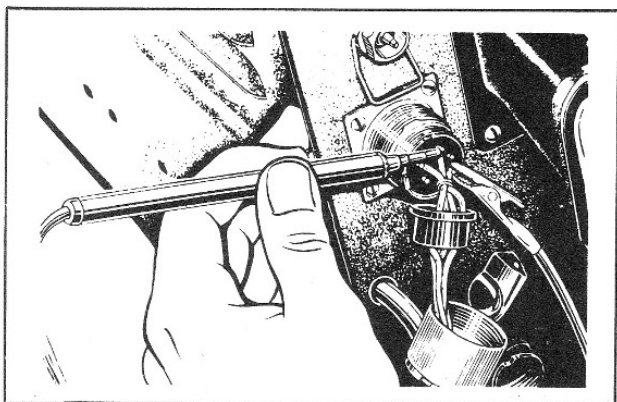


Figure 2-3

a. EQUIPMENT REQUIRED.—The following table lists the equipment required for adjustment of Radar Set AN/APN-9.

Unit	Army Type Designation
Test Set	I-56-K
Test Set	TS-251/UP
Voltmeter	IS-89
Oscilloscope	RCA #158
Signal Generator	I-72
Frequency Meter Set	SCR-211()

b. POWER SUPPLY VOLTAGE CHECK.—Be sure that the main power supply is turned off.

Step 1. Turn the "RECEIVER GAIN" control knob to the maximum counterclockwise position marked "POWER OFF."

Step 2. Connect the power cable to the connector marked "POWER SUPPLY."

Step 3. Disassemble the power cable connector and attach the leads from Voltmeter IS-189 to the exposed terminals, No. 1 and No. 3, of the power cable for the 115-volt reading, and to terminals No. 1 and No. 2 for the 80-volt reading. If a four-wire cable is used, short the leads to terminals No. 4 and No. 6 to start the power source. Remove this short after the reading has been made. Turn the main power supply on and note the reading on the voltmeter. After reading the indicated voltage,

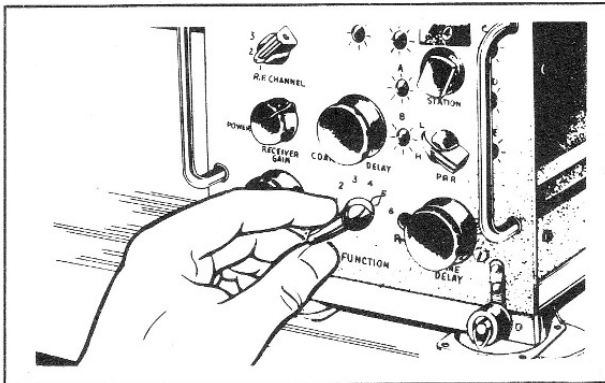


Figure 2-48

Step 40. Turn the "FUNCTION" switch to position "5," and complete the reading of the indicated time difference.

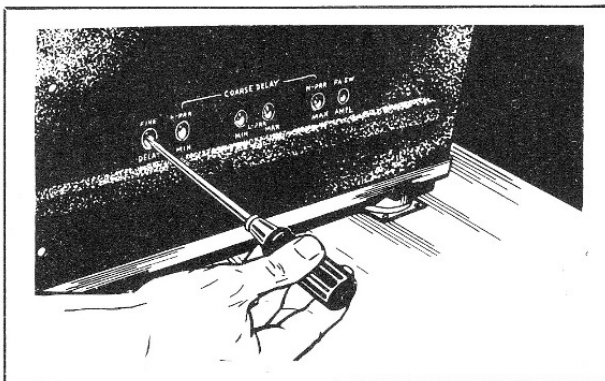


Figure 2-49

Step 41. Using the readings obtained in steps 38 and 40, the difference in microseconds should not be less than 700 microseconds, nor more than 1500 microseconds. If outside these limits, adjust the "FINE DELAY" screwdriver adjustment to provide 950 microseconds range as measured in steps 37 to 40 inclusive.

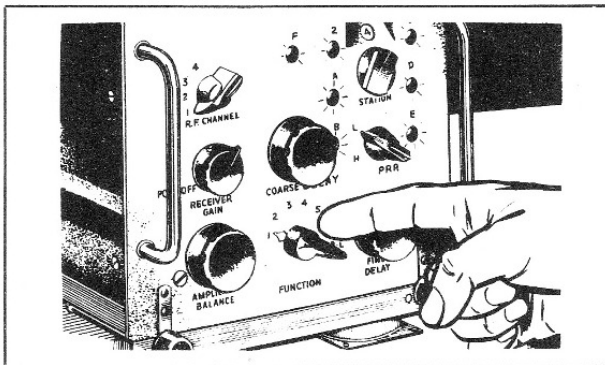


Figure 2-50

Step 42. Turn the "FUNCTION" switch to position "1."

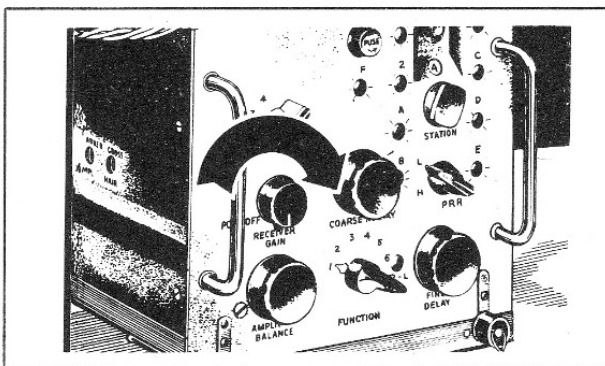


Figure 2-51

Step 43. Turn the "RECEIVER GAIN" control to the maximum clockwise position.

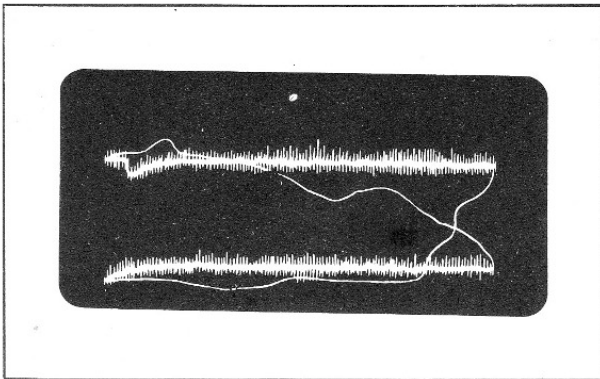


Figure 2-52

Step 44. Observe the height of the *grass* on the screen of the receiver-indicator, and note that the space between the *grass* at the upper and lower trace is not more than shown in the above illustration. Turn the "R.F. CHANNEL" switch to positions "2," "3," and "4," and at each position, note that the *grass* amplitude is not less than that shown in the above illustration. (See section V, par. 6.)

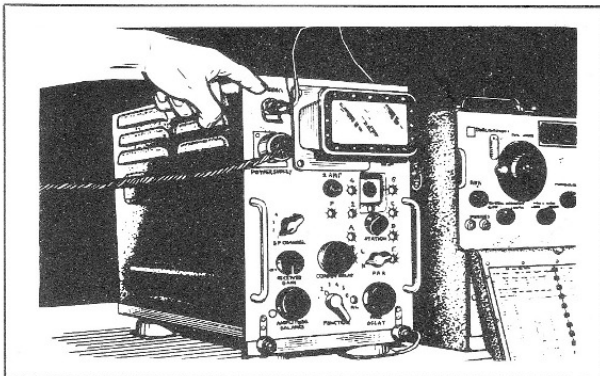


Figure 2-53

Step 45. To check the amplitude balance of the receiver-indicator, attach the lead from Frequency Meter SCR-211, listed in the beginning of this procedure, to the "ANTENNA" post of the receiver-indicator. Tune the frequency meter to the frequency of receiver-indicator as determined by the "R.F. CHANNEL" switch and turn the "FUNCTION" switch of the receiver-indicator to position "2." Turn the "RECEIVER GAIN" control to its maximum clockwise position and turn the "AMPLITUDE BALANCE" control to its maximum clockwise position.

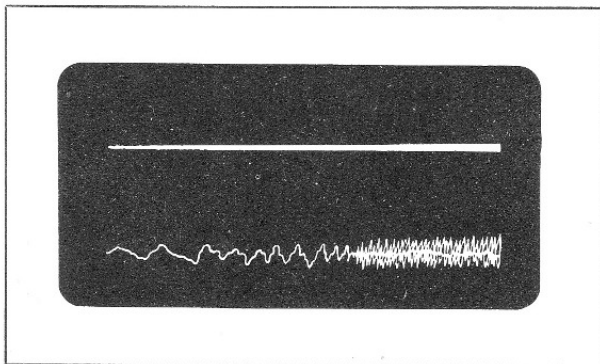


Figure 2-54

Observe that *grass* appears on one trace only.

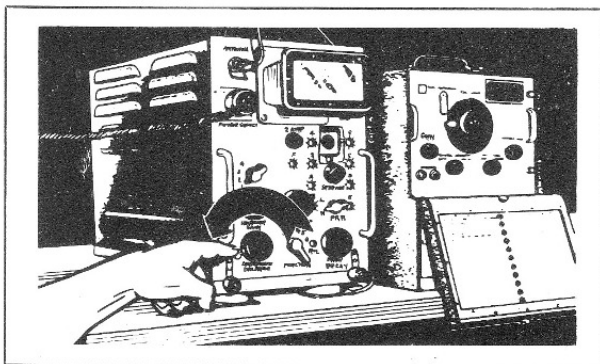


Figure 2-55

Step 46. Rotate the "AMPLITUDE BALANCE" control to the maximum counterclockwise position and observe that *grass* now appears on the other trace only. (See section V, par. 6.)

that the variable delay marker in "FUNCTION" switch position "4" is actually to the *right* of the 1,000 microsecond delay marker to which it appeared coincident. The operator is now able to compute the correct number of complete 1,000-microsecond intervals. To this amount, add the total fine reading obtained in "FUNCTION" switch position "5."

e. The final reading obtained in positions "4" and "5" should approximate the total estimated

reading made in position "4."

Step 7. With the true value of the *Indicated Time Difference* established, locate the position of the airplane on one LORAN line of position by referring to the LORAN charts. The entire operation procedure as described in section III, paragraph 3, must now be repeated to establish the second LORAN line of position. The intersection of the two LORAN lines of position *fixes* the position of the airplane.

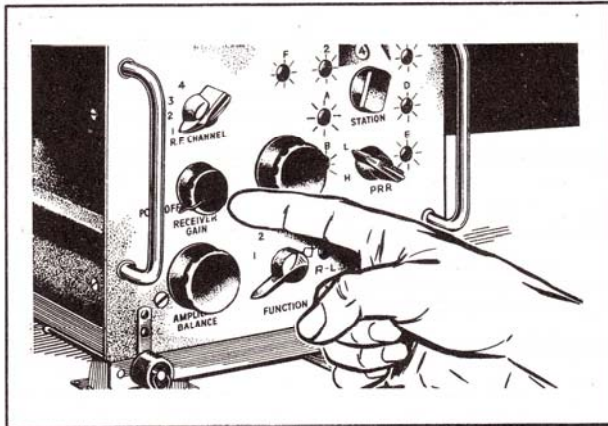


Figure 3-33

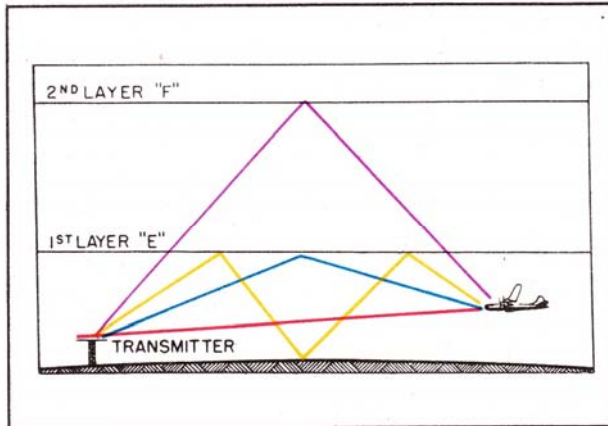


Figure 3-34

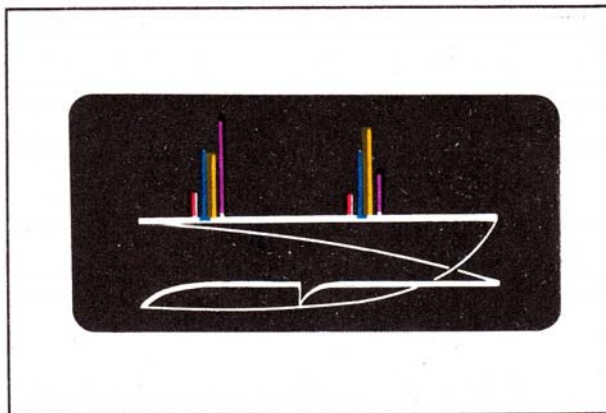


Figure 3-35

(5) "OFF" PROCEDURE.—When the operator has completed operating the receiver-indicator, turn "RECEIVER GAIN" control to "POWER OFF" position and check to see that the pilot light is not illuminated and the pattern on the indicator screen has disappeared.

b. OPERATION WITH GROUND WAVES ACCOMPANIED BY SKY WAVES

(1) During operation, multiple signal reception often occurs due to the reception of both ground waves and sky waves. Figure 3-34 shows the paths of ground waves and sky waves.

The ground wave path (red) is the most direct path between the transmitting station and the airplane, while the sky waves follow a longer path depending upon the number of reflections from ionosphere and the ground during the path of travel between the *transmitting station and the airplane*. The sky wave path reflected from the first layer of the ionosphere (blue) is the next most direct path between the transmitting station and the airplane.

(2) Figure 3-35 shows the pulses as they might appear on the indicator screen in "FUNCTION" switch position "1." The received signals are shown in color so that the operator may, by comparing figures 3-34 and 3-35, see the relationship between the paths of the various waves and the order in which they appear on the indicator screen.

(3) The operation of the receiver-indicator, during the reception of ground waves accompanied by sky waves, is exactly the same as outlined in section III, paragraph 3a.

(4) During reception of ground waves accompanied by sky waves, it is extremely important for the operator to distinguish ground waves from sky waves, and to use only the corresponding *ground wave signals* in each train of multiple signals.

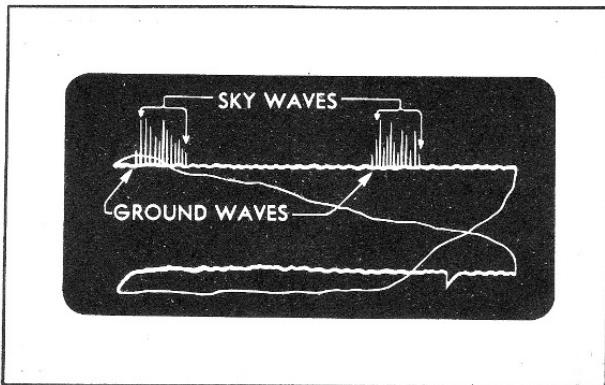


Figure 3-36

Figure 3-36 shows the multiple signals resulting from simultaneous reception of ground waves and sky waves with the "FUNCTION" switch at position "1." The ground wave will always be the pulse preceding a multiplicity of sky wave pulses and the operator must match the ground wave of one train of signals with the corresponding ground wave of the other train of signals.

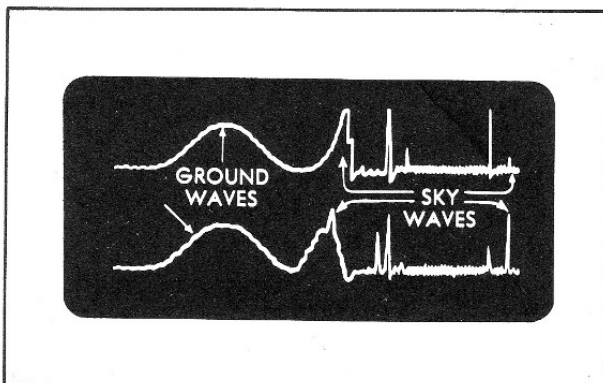


Figure 3-37

(5) Figure 3-37 shows the pattern of ground waves and sky waves with "FUNCTION" switch at position "2."

(6) To ascertain that the first pulse actually is the ground wave from the transmitting station, move both trains of signals to the right side of the indicator screen by the use of "LEFT-RIGHT" switch, and check that no other signals appear to the left of the signal identified as the ground wave.

(7) Turn "RECEIVER GAIN" control clockwise and check that no weak signal appears preceding the strong easily visible signals.

(8) Another characteristic of sky waves to be observed, is that the sky waves will have tendency to *fade*; that is, their height will tend to vary while a ground wave should remain constant.

c. OPERATION WITH SKY WAVES.

(1) During operation with sky waves only, it is extremely important that the operator matches the first sky pulses in each train of sky pulses. Figure 3-38 illustrates sky wave pulse trains as they appear with the "FUNCTION" switch at position "1."

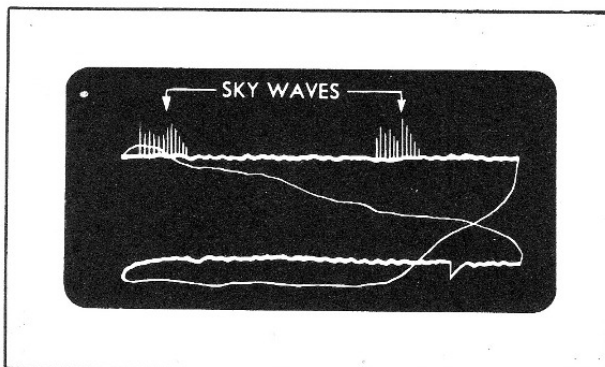


Figure 3-38

(2) In "FUNCTION" switch position "2" the sky wave trains will appear as shown in figure 3-39. To ascertain that the sky waves selected to be matched are the first received sky wave signals, the operator should follow the instructions outlined in paragraph 3b, this section.

(3) If the sky waves tend to *split*, matching of the selected sky waves pulses becomes difficult. The following illustrations show a half of a splitting cycle during which the leading edge of the pulse indication is distorted, as it might be observed with the "FUNCTION" switch in positions "2," "3," or "6."

For the purpose of clarity, the sky pulses which are not used have been omitted from the following illustrations and only the first sky pulse is shown, since it is the only such pulse used for matching.

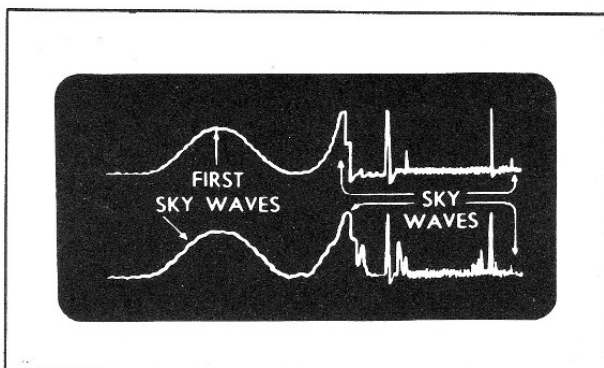


Figure 3-39

4. INDICATIONS FOR CORRECT TIMING.

The adjustments as outlined in paragraph 3, this section, will provide the correct result only if the *counter indications* and *station rates* are adjusted correctly. If the receiver-indicator cannot be synchronized with the ground stations, the expected stations are not received, or the *fix* does not correspond with the expected location. Check the *counter-indications* and *station rates* as follows:

a. COUNTER INDICATIONS.

Step 1. Turn the "FUNCTION" switch to position "4" and the "COARSE DELAY" switch to the approximate center of its range.

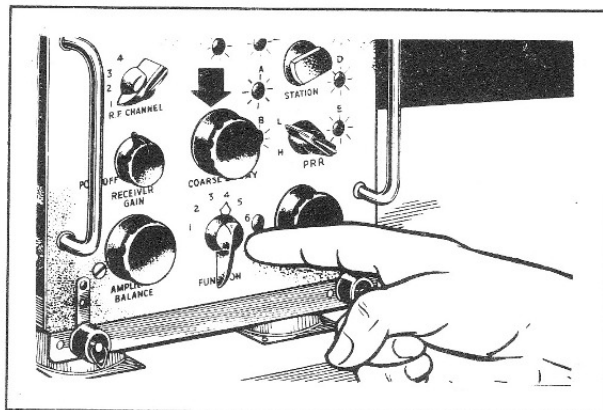


Figure 3-47

Step 2. Turn the "PRR" switch to position "H."

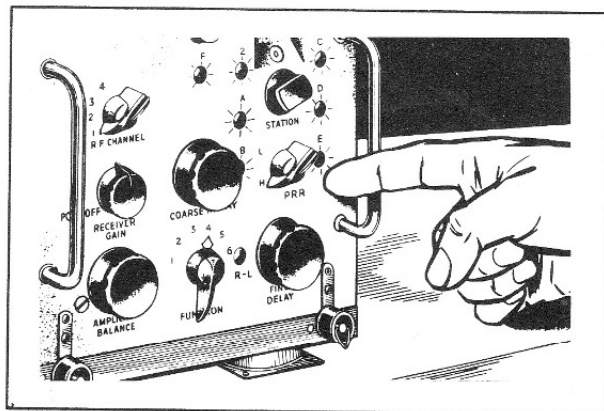


Figure 3-48

Step 3. Count *three* 5,000-microsecond intervals between the extreme right and left ends of the trace.

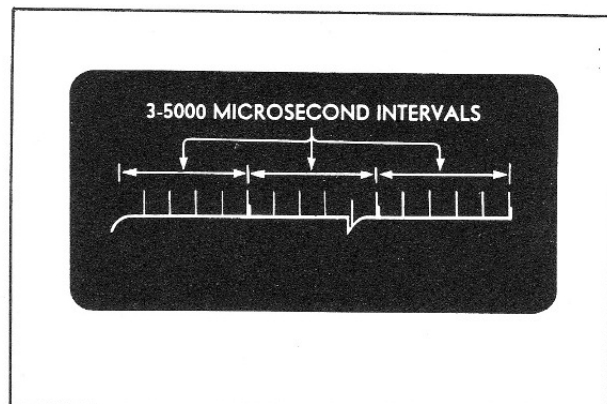


Figure 3-49

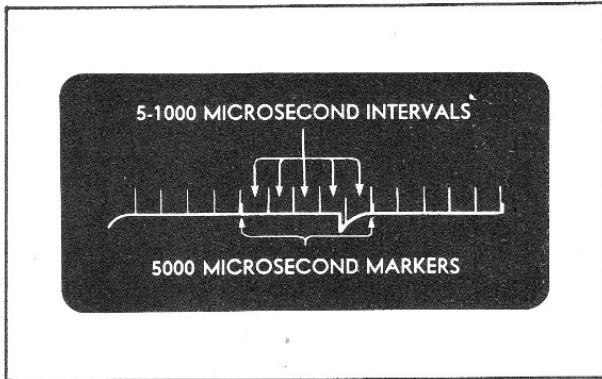


Figure 3-50

Step 4. Count five 1,000-microsecond intervals between the 5,000-microsecond markers.

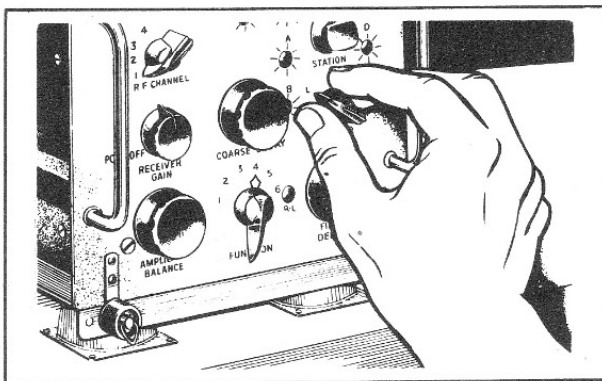


Figure 3-51

Step 5. Turn the "PRR" switch to position "L."

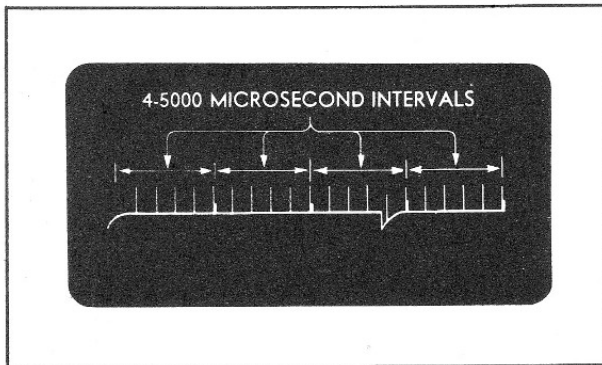


Figure 3-52

Step 6. Count four 5,000-microsecond intervals between the extreme right and left ends of the trace.

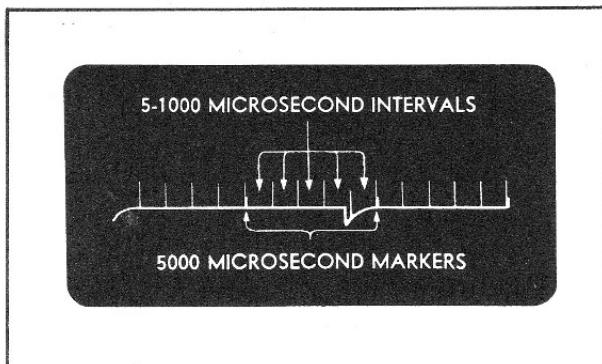


Figure 3-53

Step 7. Count five 1,000-microsecond intervals between the 5,000-microsecond markers.

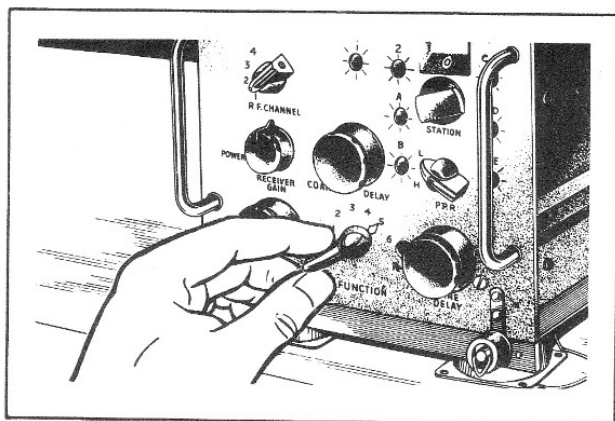


Figure 3-54

Step 8. Turn the "FUNCTION" switch to position "5"

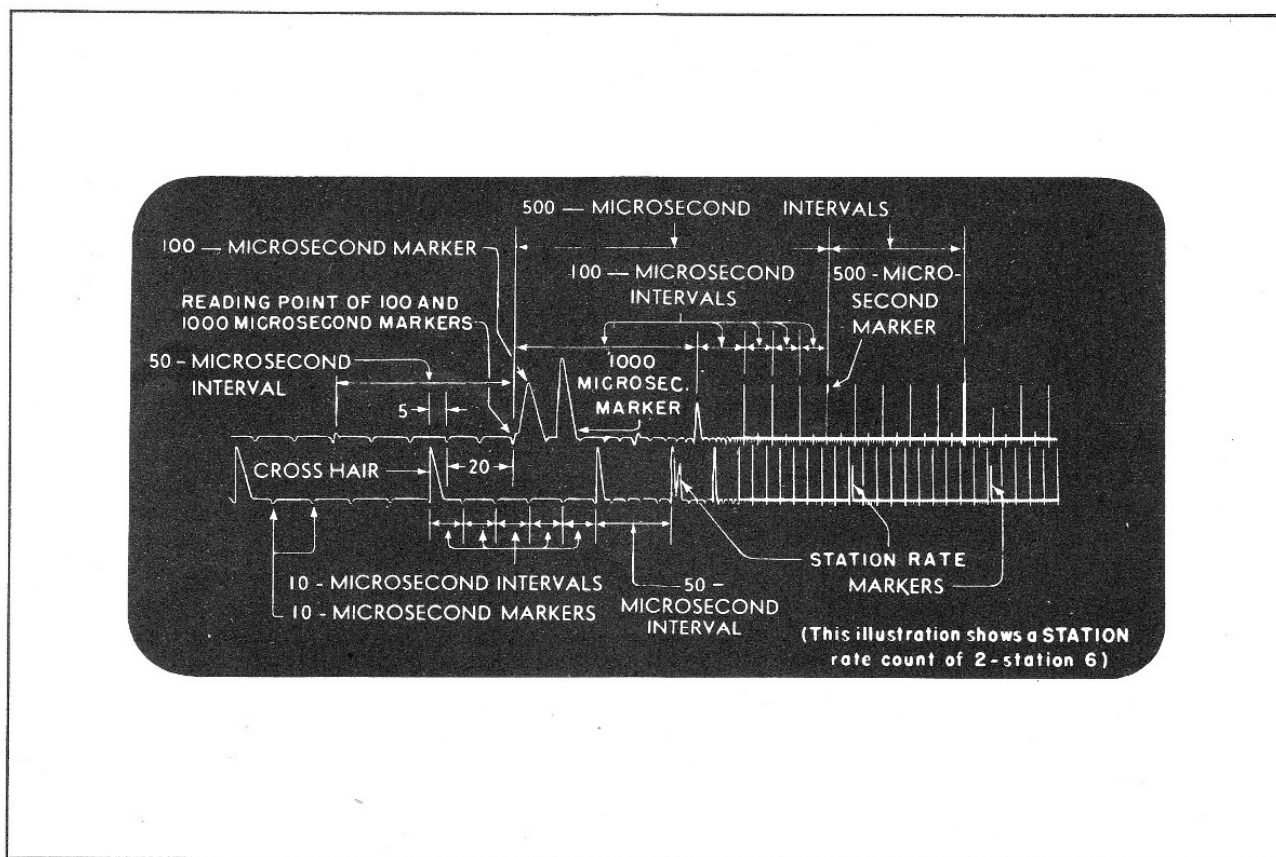


Figure 3-55

Step 9. Count five 10-microsecond intervals between 50-microsecond markers on the lower trace.

Step 10. Count two 50-microsecond intervals between 100-microsecond markers on the upper trace.

Step 11. Count five 100-microsecond intervals between 500-microsecond markers on the upper trace.

Step 12. Count two 500-microsecond intervals between 1,000-microsecond markers on the upper trace.

Note

The operator must become thoroughly familiar with the above counter indications, so that he may, during operations, notice any deviations from the correct indications outlined above.

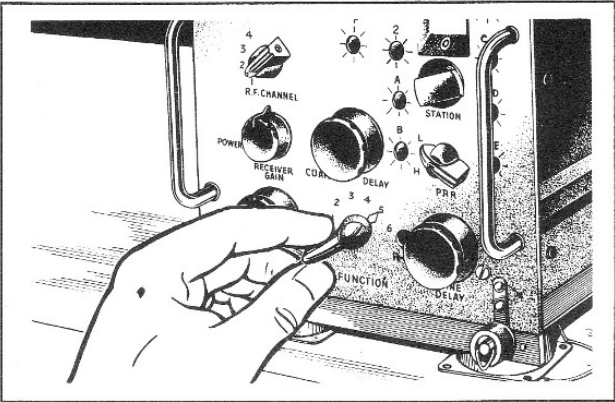


Figure 3-56

b. STATION FEED-BACK RATES.

Step 1. Turn the "FUNCTION" switch to position "5" and the "COARSE DELAY" switch to the approximate center of its range.

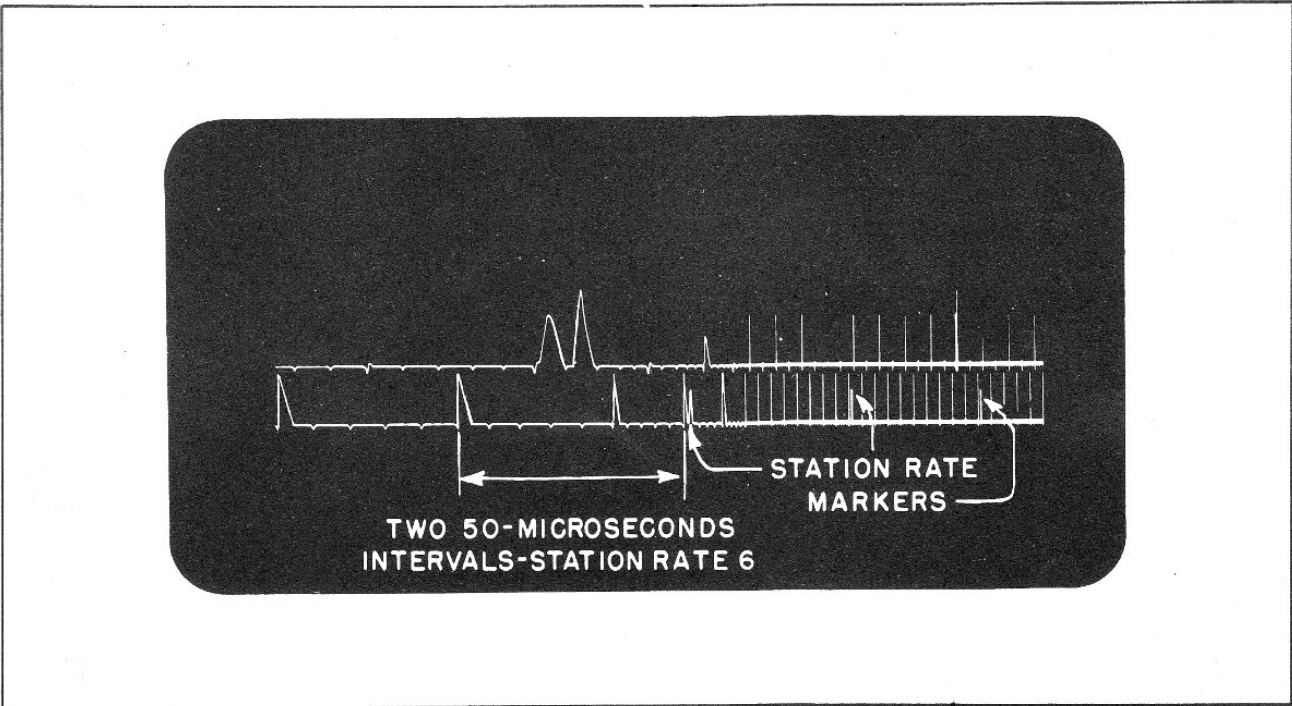


Figure 3-57

Step 2. Observe the station rate markers on the lower trace. Set the "STATION" switch at "0" and count the number of 50-microsecond intervals between the cross hair and the first station rate marker. Repeat this operation for "STATION" settings "1" to "7," inclusive. The counts observed must agree with the table below.

"STATION" Switch Setting	50- Microsecond Intervals
0	8
1	7
2	6
3	5
4	4
5	3
6	2
7	1

Step 3. With the "STATION" switch set at position "4," move the "LEFT-RIGHT" switch to "RIGHT" position and count two 50-microsecond intervals between the cross hair and the first station rate marker.

Repeat the preceding steps 2 and 3 with the "PRR" switch set at the "H" and "L" positions.

Note

If the above indications show a faulty count or station rate adjustment, or if the "LEFT-RIGHT" switch action is unsatisfactory with the "FUNCTION" switch at position "1," refer to section V, paragraph 8.b.

5. EMERGENCY OPERATIONAL ADJUSTMENTS.

The following adjustments are to be made only after the operator has checked the indications for correct timing (refer to paragraph 4, this section) and has found that the equipment does not function properly.

a. FUSES.—If the pilot light is not illuminated and no trace pattern appears on the indicator screen, replace the active fuse with the spare fuse located under the lens holder.

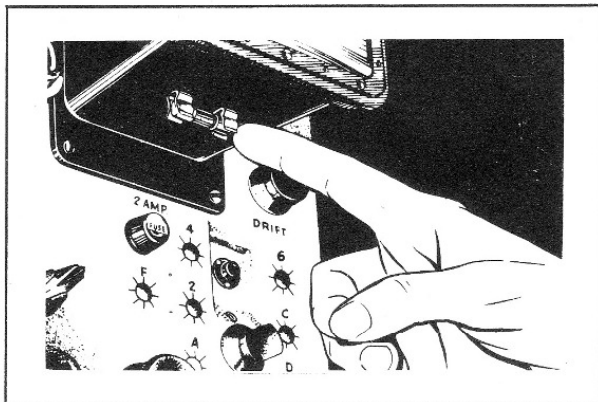


Figure 3-58

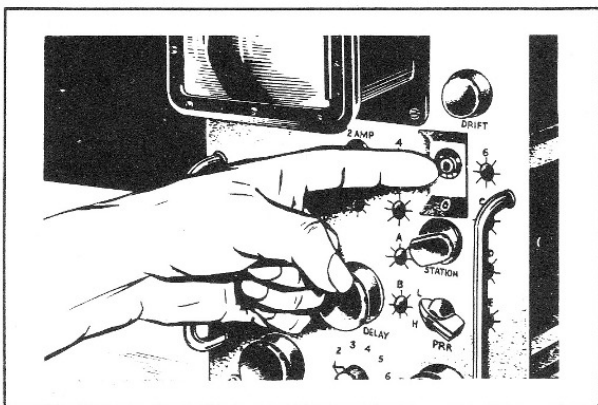


Figure 3-59

b. PILOT LIGHT.—If the pilot light is not illuminated and the trace pattern appears on the indicator screen, replace the pilot light. However, the equipment will operate without the pilot light being illuminated.

c. COUNTER ADJUSTMENTS.

Note

These are step adjustments in which the count changes in steps as the screw driver adjustment is moved. When making adjustments, attempt to set the control in the center of the range which produces the correct count. Make these adjustments only if certain that the count is incorrect. *Only the incorrect count should be adjusted.* The set must be realigned in a maintenance shop as soon as possible after such emergency adjustments have been made.

(1) THREE 5,000-MICROSECOND INTERVAL COUNT.

Step 1. Set the "FUNCTION" switch at position "4," the "PRR" switch at "H," the "STATION" switch at "0," and the "COARSE DELAY" control at its maximum clockwise position.

Step 2. Adjust screw driver control "D" on the front panel until three 5,000-microsecond intervals appear between the extreme right and left ends of the trace. (See figure 3-49.)

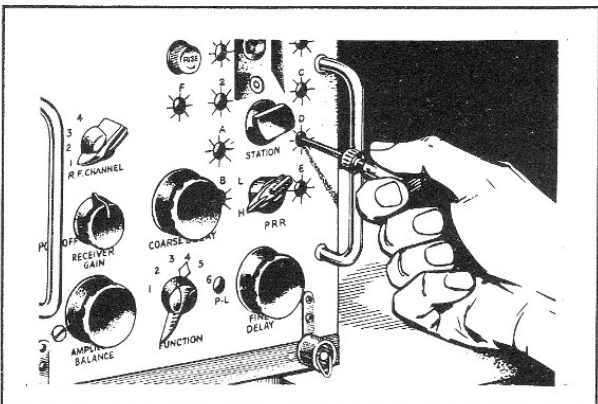


Figure 3-60

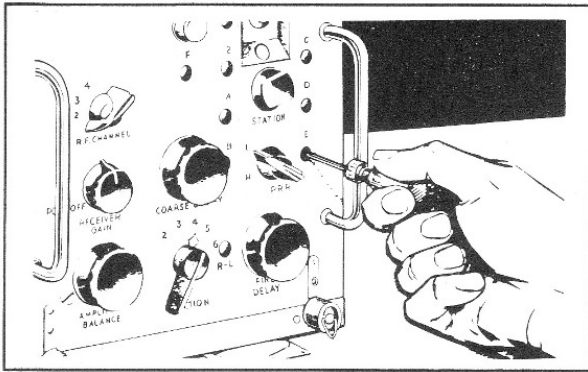


Figure 3-61

(2) FOUR 5,000-MICROSECOND
INTERVAL COUNT.

Step 1. Set the "FUNCTION" switch at position "4," the "PRR" switch at position "L."

Step 2. Adjust "E" screw driver control on the front panel until four 5,000-microsecond intervals appear between the extreme right and left ends of the trace.

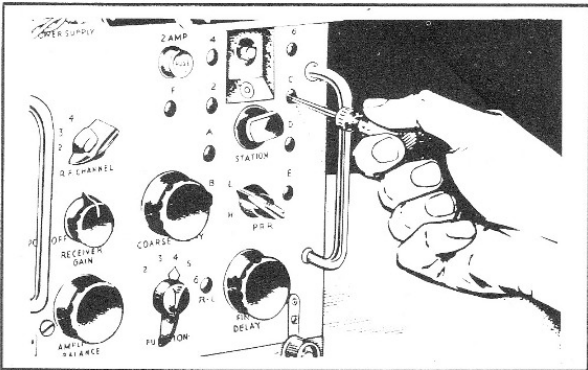


Figure 3-62

(3) FIVE 1,000 - MICROSECOND INTERVAL COUNT.—With the "FUNCTION" switch at position "4," adjust the "C" screw driver control on the front panel until five 1,000-microsecond intervals appear between the 5,000-microsecond markers.

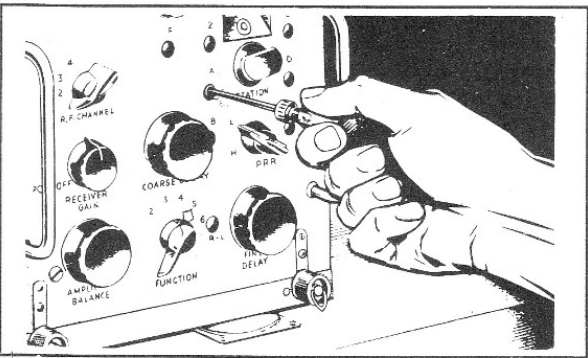


Figure 3-63

(4) 10-MICROSECOND INTERVAL COUNT.—With the "FUNCTION" switch set to position "5," adjust the "A" screw driver control on the front panel, until five 10-microsecond intervals appear between the 50-microsecond markers.

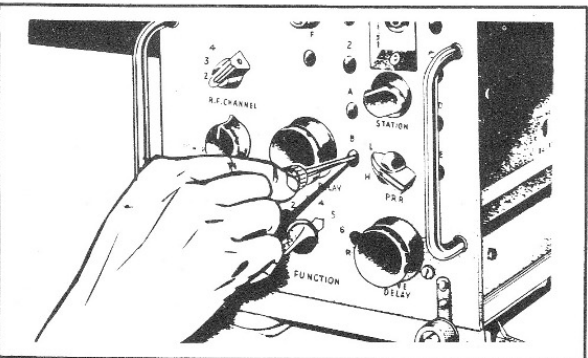


Figure 3-64

(5) 100 - MICROSECOND INTERVAL COUNT. With the "FUNCTION" switch set to position "5," adjust the "B" screw driver control on the front panel until five 100-microsecond intervals appear between the 500-microsecond markers.

d. STATION RATE ADJUSTMENTS.

Note

These are step adjustments in which the *station rate* changes in steps as the screw driver adjustment is moved. When making adjustments, attempt to set the control in the center of the range which produces the correct station rate. Make these adjustments only if certain that the count is correct. The set must be re-aligned in a maintenance shop as soon as possible after such emergency adjustments have been made.

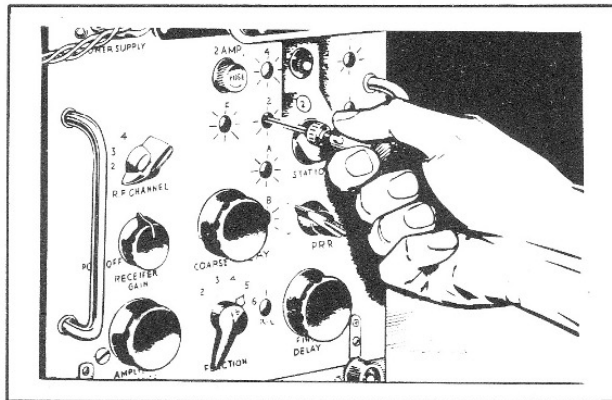


Figure 3-65

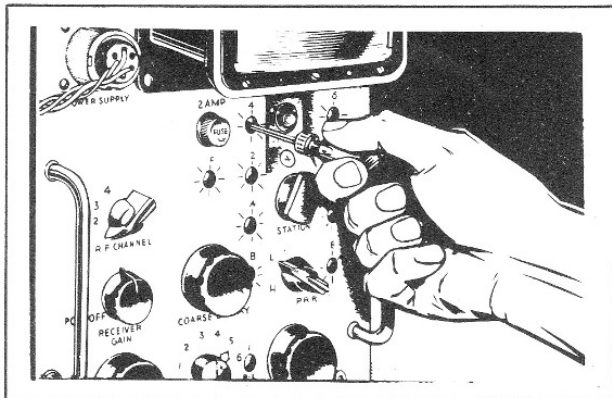


Figure 3-66

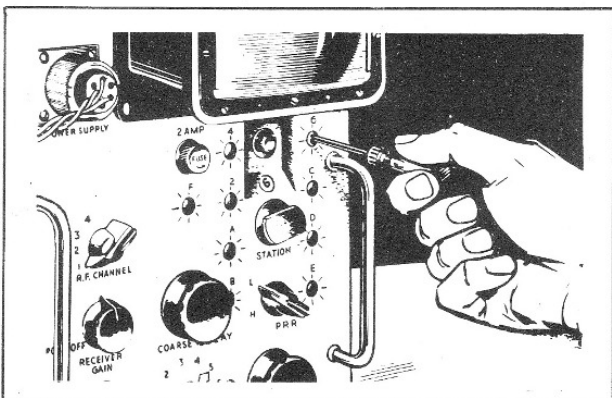


Figure 3-67

When the "STATION" switch settings do not agree with the 50-microsecond interval counts as listed in paragraph 4b, this section, Step 2, this section, the following adjustments will be necessary.

Step 1. When "STATION" switch setting "0" is incorrect, center the controls as described in section III, paragraph 5c (1) to (5), inclusive.

Step 2. When "STATION" switch setting "1" is incorrect, center the controls as described in paragraph 5c (1) to (5), this section.

Step 3. When "STATION" switch setting "2" is incorrect, adjust screw driver control "2" on the front panel until there are six 50-microsecond intervals between the cross hair and the first brilliant marker on the lower trace. If this adjustment is not possible, center the adjustment of the controls as outlined in section III, paragraph 5c (1) to (5), this section. The "FUNCTION" switch is set at position "5" for this adjustment.

Step 4. When "STATION" switch setting "3" is incorrect, repeat step 3 as described directly above. If a correct count is not produced, center the controls as described in paragraph 5c (1) to (5), above.

Step 5. When "STATION" switch setting "4" is incorrect, adjust screw driver control "4" on the front panel until there are four 50-microsecond intervals between the cross hair and the first station rate marker on the lower trace. The "FUNCTION" switch is set at position "5" for this adjustment. If this adjustment is not possible, center the adjustment of the controls as described in paragraph 5c (1) to (5), above.

Step 6. When "STATION" switch setting "5" is incorrect, repeat step 5 as described. If a correct count is not produced, center the controls as described in paragraph 5c (1) to (5), above.

Step 7. When "STATION" switch setting "6" is incorrect, adjust screw driver control "6" on the front panel until there are two 50-microsecond intervals between the cross hair and the first station rate marker on the lower trace. If this adjustment is not possible, center the adjustment of the controls as outlined in paragraph 5c (1) to (5), above. The "FUNCTION" switch is set at position "5" for this adjustment.

Step 8. When "STATION" switch setting "7" is incorrect, repeat Step 7. If the correct count is not produced, center the adjustment of the controls as described in paragraph 5c (1) to (5), above.

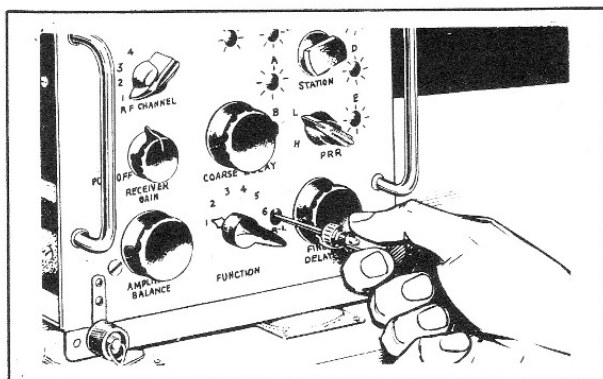


Figure 3-68

e. **LEFT-RIGHT CONTROL.**—If the "RIGHT" action of the "LEFT-RIGHT" switch is unsatisfactory with the "FUNCTION" switch set at position "1," adjust screw driver adjustment "R-L" on the front panel until the "RIGHT" action is satisfactory. Use signals for indications.

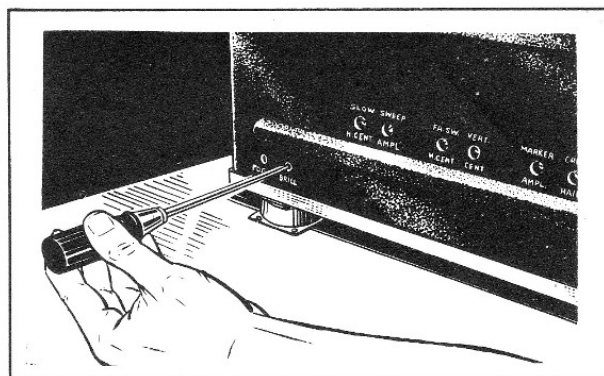


Figure 3-69

f. **BRILLIANCE CONTROL.**—Watch the indicator screen. If no trace has appeared, turn the "FUNCTION" switch to position "5," and adjust the "BRILL." screw driver control, on the left side panel of the receiver-indicator until the trace appears.

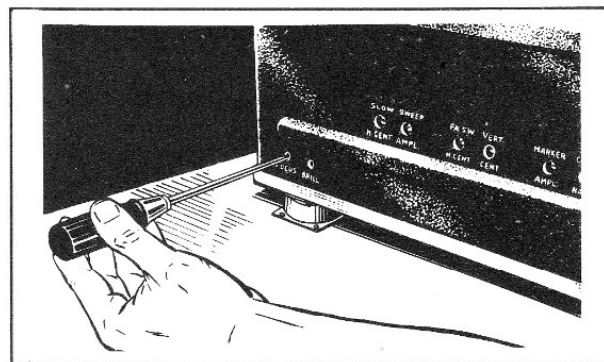


Figure 3-70

g. **FOCUS CONTROL.**—If the trace is blurred, . . .

With the "FUNCTION" switch in position "5," adjust the "FOCUS" screw driver control on the panel on the left side of the receiver-indicator until the trace is sharp and clear.

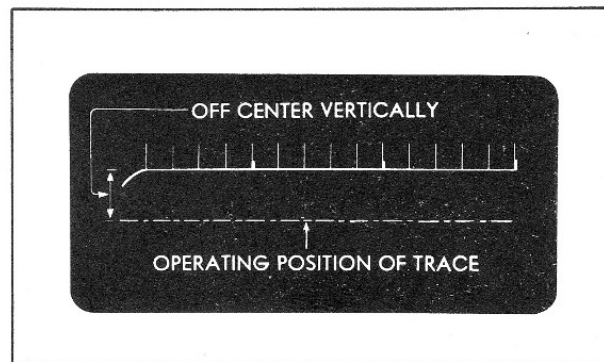


Figure 3-71

b. **CENTERING OF TRACES.**

(1) To center the trace *vertically* with the "FUNCTION" switch set at positions "1," "2," "3," "4," "5," or "6," proceed as follows:

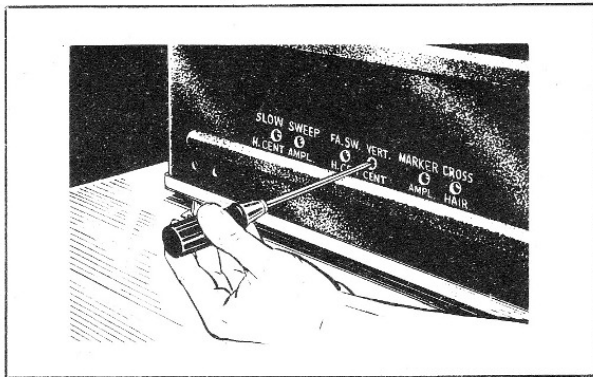


Figure 3-72

Adjust the "VERT. CENT." control on the left side of the receiver-indicator until the trace is correctly centered.

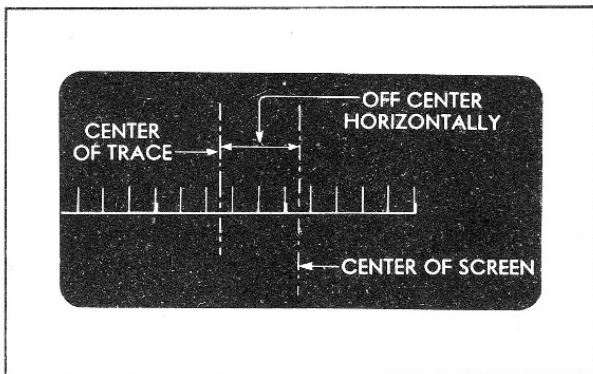


Figure 3-73

(2) To center the trace *horizontally*, with the "FUNCTION" switch set at position "1" or "4," proceed as follows:

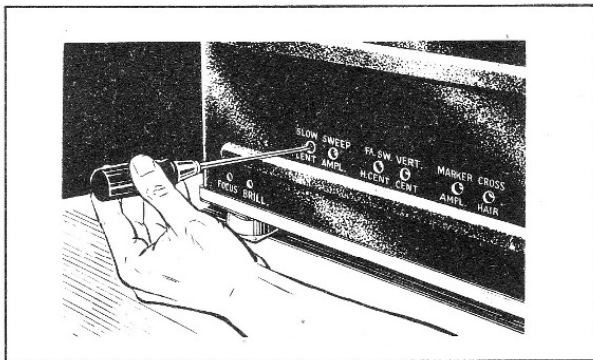


Figure 3-74

... Adjust the "SLOW SWEEP H. CENT." screw driver control on the left-hand side until the trace is properly centered.

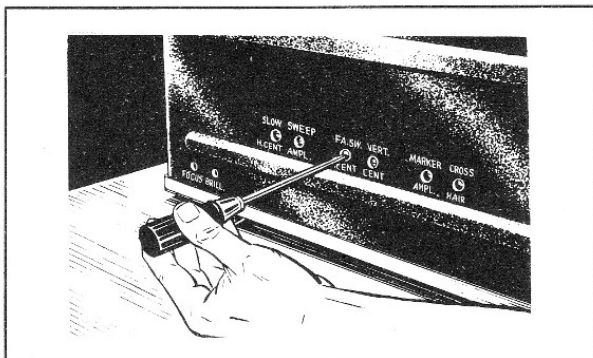


Figure 3-75

(3) To center the trace *horizontally* with the "FUNCTION" switch set at positions "2," "3," "5," or "6," proceed as follows:

Adjust the "FA. SW. H. CENT." screw driver control on the left-hand side of the receiver-indicator until the traces are properly centered.

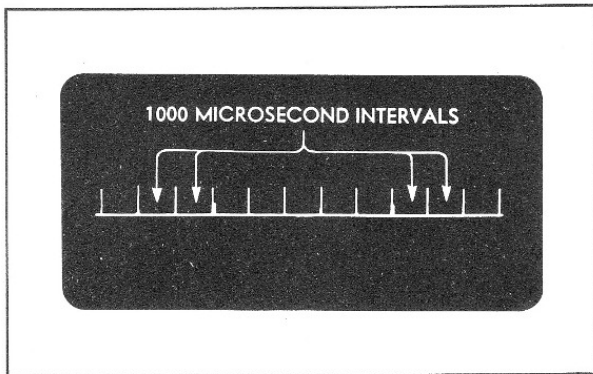


Figure 3-76

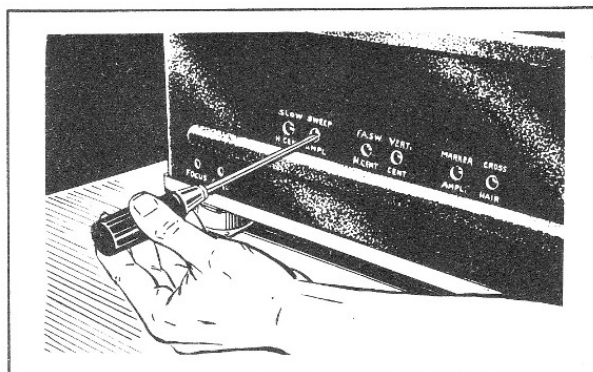


Figure 3-77

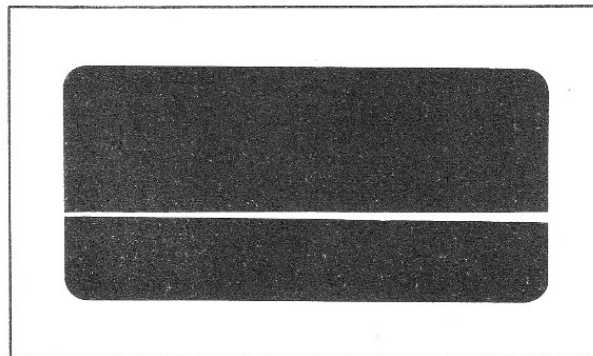


Figure 3-78

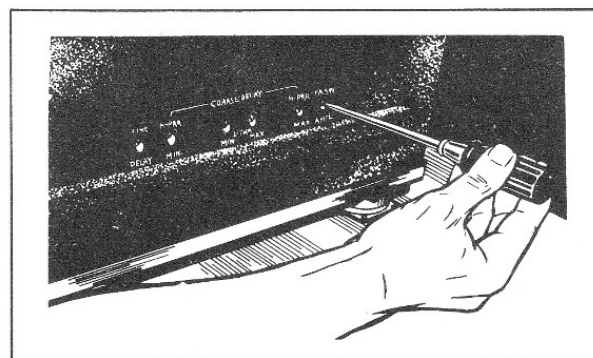


Figure 3-79

i. AMPLITUDE OF TRACES.

(1) To adjust amplitude of traces with "FUNCTION" switch set at positions "1" or "4," proceed as follows:

If trace amplitude is incorrect, that is, the length of the trace is too long or too short . . .

. . . Adjust the "SLOW SWEEP AMPL." screw driver control on the left side until the trace assumes a normal length.

(2) To adjust the amplitude of the traces with the "FUNCTION" switch set at positions "2," "3," "5," or "6," proceed as follows: If the length of the traces is too long or too short . . .

Adjust the "FA. SW. AMPL." screw driver control on the right-hand side of the receiver-indicator until the traces assume a normal length.

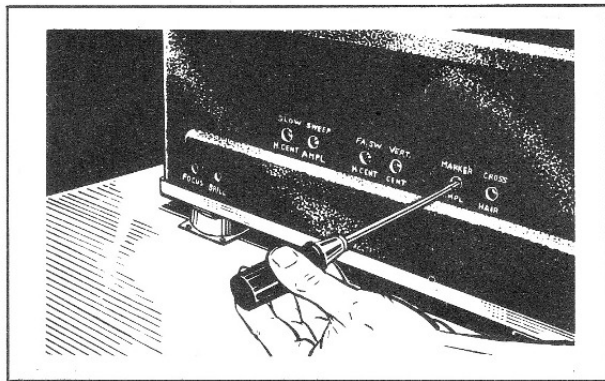


Figure 3-80

j. MARKER SIZE ("FUNCTION" SWITCH POSITION "5").—If the heights of the markers, do not permit the operator to identify them readily, adjust the "MARKER AMPL." control on the left-hand side of the receiver-indicator.

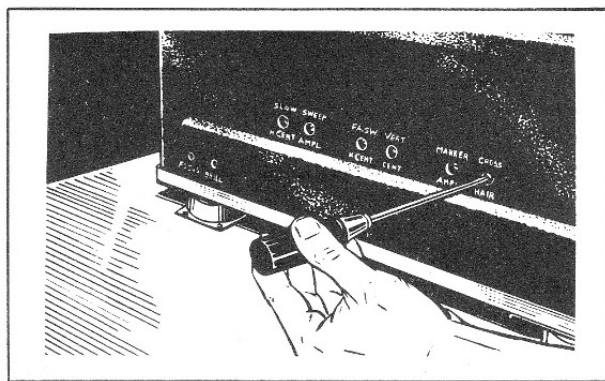


Figure 3-81

k. CROSS HAIR ("FUNCTION" POSITION "5.").—If the position of the cross hair in relation to the upper trace is incorrect, adjust the "CROSS HAIR" screw driver control on the left-hand side of the receiver-indicator.

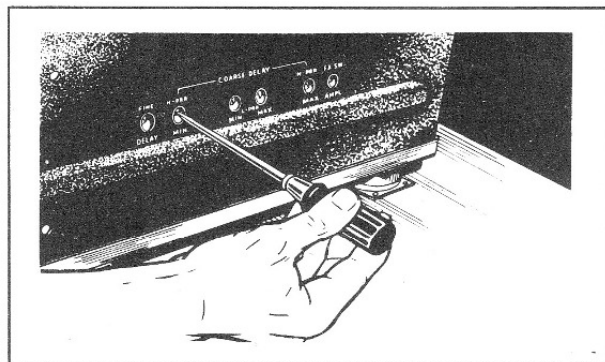


Figure 3-82

l. COARSE DELAY.—If the range of the "COARSE DELAY" control is insufficient to adjust the delay for a desired station, proceed as follows:

Step 1. If the variable delay marker cannot be placed far enough to the right with the "PRR" switch set at "H," adjust the "COARSE DELAY H-PRR MIN." screw driver control on the right side of the receiver-indicator.

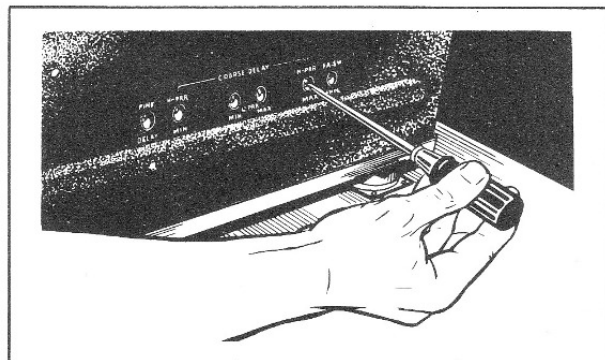


Figure 3-83

Step 2. If the variable delay marker cannot be placed far enough to the left with the "PRR" switch set at "H," adjust the "COARSE DELAY H-PRR MAX." control on the right side of the receiver-indicator.

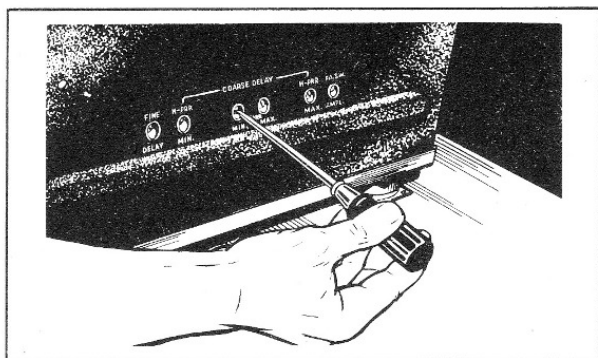


Figure 3-84

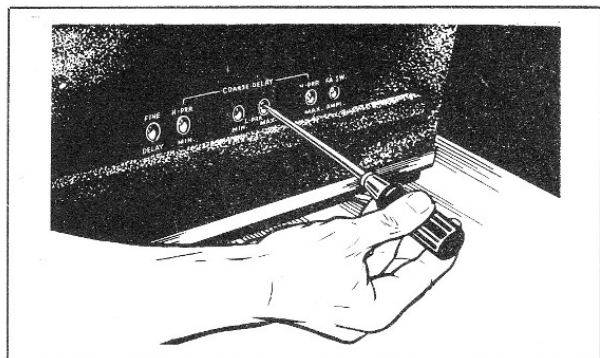


Figure 3-85

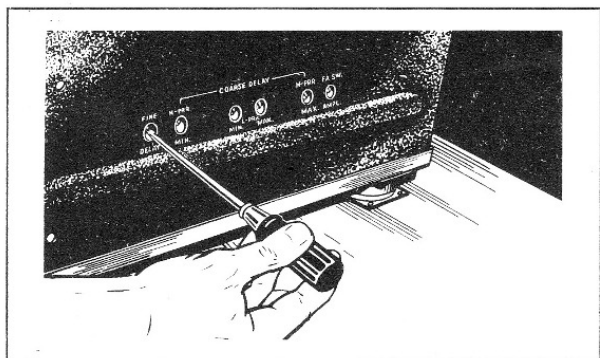


Figure 3-86

Step 3. If the variable delay marker cannot be placed far enough to the *right* with the "PRR" switch set at "L," adjust the "COARSE DELAY L-PRR MIN." control on the right side of the receiver-indicator.

Step 4. If the variable delay marker cannot be placed far enough to the left with the "PRR" switch set at "L," adjust the "COARSE DELAY L-PRR MAX." control on the right side of the receiver-indicator.

m. FINE DELAY.—If the "FINE DELAY" range is not sufficient (700 microseconds), adjust the "FINE DELAY" adjustment on the right-hand side of the receiver-indicator.

6. DEFENSE AGAINST JAMMING.

(See section VI, paragraph 11.)

a. DEFINITION.—Jamming is the intentional generation by the enemy of radio signals designed to interfere with the use of Radar Set AN/APN-9. Natural interference may result in indications similar to jamming effects and may be frequently surmounted by procedures effective in minimizing intentional jamming.

b. EFFECT OF JAMMING.—Several types of jamming are likely to be used by the enemy. They all give various kinds of spurious signals on the indicator which make the normal signals difficult to see and measure.

c. RECOGNIZING JAMMING.—If Radar Set AN/APN-9 is defective, it is possible that it can produce

effects similar to jamming. Remove the antenna lead to the receiver-indicator and if the interference disappears the interfering signal is coming from outside the set. If the interference does not disappear, the set is defective.

d. ACTION.—Report jamming to the commanding officer immediately.

e. ANTI-JAMMING PROCEDURE.

- (1) Keep calm and think about what you are doing.
- (2) Try all positions of the "RECEIVER GAIN" control from high to low and determine which position gives the best signal indication.
- (3) Switch to alternate stations on different frequencies and determine which is the best.

layers of free electrons which would reflect radio waves are designated as the E- and F-Layers. Referring to figure 4-4, and bearing in mind that the transit time depends upon the length of the signal path, it is possible to draw the following conclusions:

All reflected signals are delayed by greater intervals than ground wave signals.

The greater the number of reflections, the greater the interval of delay.

Signals reflected from the F-Layer have a greater interval of delay than signals reflected from the E-Layer.

Whenever possible, LORAN measurements are made by using the ground wave (shown in red). All other LORAN measurements are made by using the *first* reflection from the E-Layer (shown in blue).

The reflection of waves sometimes results in the effect of *splitting* of the pulse image as it appears on the indicator screen. *Splitting* causes the pulse to vary constantly in shape by assuming double or multiple humped forms.

2. MECHANICAL CHARACTERISTICS.

a. MOUNTING.—Receiver-Indicator R-65/APN-9 is designed to be mounted on Mounting Bracket MT-203/APN or FT-446. (See figure 1-3.) The equipment is secured to the shock mount by two spring plungers in the rear, and two knurled thumb nuts that engage the brackets at the bottom of the front panel.

b. OPERATIONAL CONTROLS.—All operational controls are provided with knobs located at the front panel of the equipment. The three controls requiring the most critical adjustment in operation, namely, the "AMPLITUDE BALANCE," "FINE DELAY," and "COARSE DELAY," are provided with large control knobs and friction devices which permit smooth adjustment and hold the control knobs firmly in place at the desired settings.

c. EXTERNAL SCREW DRIVER ADJUSTMENTS.

(1) All adjustments, the settings of which are determined by viewing the indicator screen, are made on screw driver adjusting controls located on either side of the equipment. These adjustments are accessible through holes in the dust cover.

(2) The screw driver adjustment controls which are accessible through holes in the front panel are normally aligned with meters. However, these adjustments may be used for emergency alignment during flight.

d. VIEWING LENS.—Lens and a rubber visor are supplied to magnify the patterns and shield the indicator screen from stray light.

e. REMOVAL OF DUST COVER AND SHIELD PLATE. (See section V, paragraphs 3a(1) and 3a(3), respectively.)—Figure 1-5 shows the equipment with the dust cover and shield plate removed, allowing access to all tubes. The two screw driver adjustments at the rear, the r-f adjustments for channels 1, 2, 3, and 4,

and the crystal grid and plate coil adjustments are also accessible.

f. REMOVAL OF FRONT PANEL. (See section V, paragraph 3a(2).)—The front panel may be removed by detaching all the control knobs, the four screws which mount the lens holder, and the two flat-head screws at the bottom. The friction adjustments of the "AMPLITUDE BALANCE," "COARSE DELAY," and "FINE DELAY" controls consist of collars on the control shafts which when adjusted, compress the friction spring washers to the required tightness. These adjustments, as well as the adjustable front bearing for the "FUNCTION" switch control shaft, are accessible with the front panel removed. (See section V, paragraphs 3c(1) and 3c(2).)

g. R-F CHANNEL SWITCH AND TRIMMER ASSEMBLY.—The "R-F CHANNEL" switch and trimmer assembly may be removed as a unit by disconnecting the six leads to the chassis and removing the three screws and one nut which hold the assembly to the inner front panel.

b. REMOVAL OF TOP CHASSIS.—The top section of the chassis may be removed to provide easier access to some component parts.

i. PHYSICAL LOCATIONS OF BASIC UNITS AND FUNCTIONAL CIRCUITS.—Figures 6-20 to 6-24 inclusive show the locations of the basic units and functional circuits shown in figures 4-40, 4-41, 4-42, 4-43, and 4-45. In all cases, the colors used to identify physical parts are the same as for those used on their respective functional blocks as shown on the block diagrams.

3. ELECTRICAL CHARACTERISTICS (CIRCUIT FUNCTIONS).

Figures 4-40, 4-41, 4-42, 4-43, and 4-45 illustrate the basic functional units of the equipment and the stages comprising each of the basic units.

a. BASIC FUNCTIONAL UNITS. (See figures 6-20 to 6-24, inclusive.)

(1) **RADIO RECEIVER.**—The radio receiver detects and amplifies the LORAN signals from the ground transmitting station and displays the signal indications on the indicator tube screen.

(2) **TIMER.**—The timer provides a time standard for use in synchronizing the deflection circuits with the received LORAN signals, and produces timing markers for measuring the delay readings on the indicator tube screen.

(3) **DELAY AND DEFLECTION CIRCUITS.**—The delay and deflection circuits provide a means of indicating variable delays, and of obtaining the required deflection voltages necessary to display the various sweep patterns in the indicator tube screen.

(4) **POWER SUPPLY.**—The power supply furnishes filament power for all tubes, unregulated plate voltage for the radio receiver and horizontal amplifier, regulated plate voltage for the timer and deflection circuits, and high voltage for operation of the indicator tube.

(5) INDICATOR TUBE.—The indicator tube is a cathode ray tube which displays the various patterns so they may be used in making the required adjustments and reading the indicated time difference.

b. FUNDAMENTAL STAGES OF FUNCTIONAL UNITS.

(1) RADIO RECEIVER.

(a) R-F AMPLIFIER AND CHANNEL SELECTOR. (See following paragraph 4a (1).)—The r-f amplifier and channel selector tunes the input to the desired r-f signal and amplifies these received signals.

(b) CONVERTER.—The converter provides a local oscillator frequency which combines with the incoming r-f signal to form the proper intermediate frequency.

(c) I-F AMPLIFIER.—The i-f amplifier amplifies the converted signal.

(d) SECOND DETECTOR.—The second detector rectifies the i-f signal and separates the LORAN signal pulses from the i-f carrier.

(e) VIDEO AMPLIFIER.—The video amplifier amplifies the LORAN signal pulses to the degree required to produce the desired signal indications on the indicator tube screen.

(2) TIMER.

(a) 100-KILOCYCLE CRYSTAL OSCILLATOR.—The 100-kilocycle crystal oscillator provides a master frequency source for use as a time standard in operating the other timing circuits and for synchronizing the deflection voltages with the LORAN signals. The "DRIFT" control provides a means of effecting small changes in the crystal circuit frequency to enable exact synchronization.

(b) 10-MICROSECOND BLOCKING OSCILLATOR.—The 10-microsecond blocking oscillator converts the output of the crystal oscillator into a series of sharp pips separated by intervals of 10 microseconds, giving a pulse repetition rate of 100 kilocycles. These pips which are fed to the first 5:1 counter circuit also appear as 10-microsecond time markers on the screen of the indicator tube.

(c) 5:1 COUNTER AND 50-MICROSECOND BLOCKING OSCILLATOR.—The 5:1 counter and 50-microsecond blocking oscillator totals the 10-microsecond pulses from the 10-microsecond blocking oscillator (paragraph (b) above). The blocking oscillator fires on every fifth pip, producing a series of pulses, spaced by time intervals of 50-microseconds, which are fed to the first 2:1 counter circuit.

(d) 2:1 COUNTER AND 100-MICROSECOND BLOCKING OSCILLATOR.—The 2:1 counter and 100-microsecond blocking oscillator counts the 50-microsecond pulses, and by firing on every second pip, produces a series of pulses, spaced at 100-microsecond intervals, which are fed to the second 5:1 counter circuit.

(e) 5:1 COUNTER AND 500-MICROSECOND BLOCKING OSCILLATOR.—The 5:1 counter and 500-microsecond blocking oscillator counts the 100-microsecond pulses, and by firing on every fifth pip, produces a series of impulses, spaced at 500-microsecond intervals, which are fed to the second 2:1 counter circuit.

(f) 2:1 COUNTER AND 1,000-MICROSECOND BLOCKING OSCILLATOR.—The 2:1 counter and 1,000-microsecond blocking oscillator counts the 500-microsecond pulses, and by firing on every other pip, produce a series of pulses, spaced at 1,000-microsecond intervals, which are fed to the third 5:1 counter circuit.

(g) 5:1 COUNTER AND 5,000-MICROSECOND BLOCKING OSCILLATOR.—The 5:1 counter and 5,000-microsecond blocking oscillator counts the 1,000-microsecond pulses, and by firing on every fifth pip, produces a series of pulses, spaced at 5,000-microsecond intervals, which are fed to the 3:1—4:1 counter circuit.

(h) 3:1 or 4:1 COUNTER AND 15,000- OR 20,000-MICROSECOND BLOCKING OSCILLATOR.—This oscillator with the "PRR" switch at H, counts 5,000-microsecond pulses and fires on every third pip, thereby producing a series of pulses spaced at 15,000-microsecond intervals; while with the "PRR" switch at L, it fires on every fourth pip, thereby producing output pulses spaced at 20,000-microsecond intervals. These intervals are equal to one-half the recurrence intervals of the LORAN signals.

(i) FEEDBACK.—The feedback circuit provides a means of reducing the pulse interval of the last counter in steps of 50 microseconds to allow conformance to the LORAN signal "PRR" station rates 0 to 7.

(j) LEFT-RIGHT CONTROL.—The "LEFT-RIGHT" control provides the means of momentarily changing the pulse frequency to allow adjustment of the phase or relative timing of the output pulses from the timer with respect to the incoming LORAN signals.

(3) DELAY AND DEFLECTION CIRCUITS.

(a) PULSE RECTIFIER, ECCLES-JORDAN TRIGGER CIRCUIT, AND CATHODE FOLLOWER.—These circuits convert the output pulses of the timer into square pulses having a duration equal to one-half the recurrence interval of the incoming LORAN signals. These square pulses are used to develop vertical deflection and blanking on the indicator tube screen in some of the "FUNCTION" switch positions and to trigger the coarse delay multivibrator.

(b) COARSE DELAY MULTIVIBRATOR.—The coarse delay multivibrator provides an indicating pulse with variable delay with respect to one of the incoming LORAN signals. The delay is controlled in 500-microsecond steps by means of the "COARSE DELAY" control.

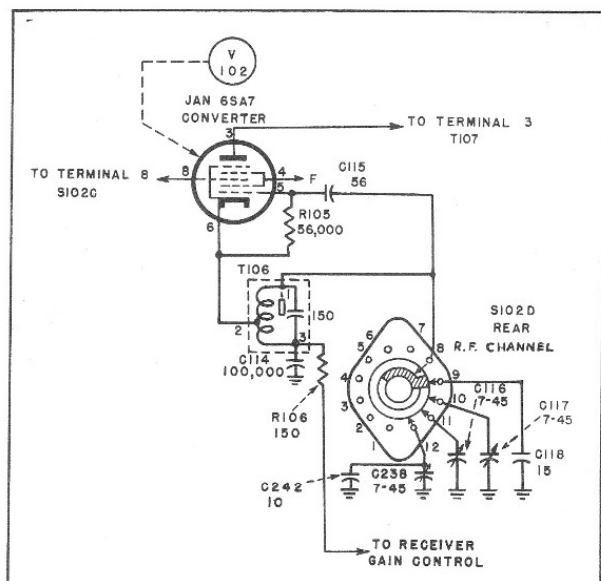


Figure 4-6. Converter Circuit—Schematic

capacity, and adjusting the circuit capacitance for resonance. The oscillator is tuned 1100 kilocycles (intermediate frequency) above the signal frequencies.

The local oscillator section of the converter tube (V-102) is electronically coupled to the signal frequency portion, and the tube, operating as a nonlinear circuit element, provides an output frequency of 1100 kilocycles (which is the difference between the oscillator and the signal frequencies).

(3) I-F AMPLIFIER.—The i-f amplifier consists of three amplifier tubes (V-103, V-104, and V-105), and four magnetically-coupled, double-tuned band pass transformers (T-107, T-108, T-109, and T-110) operating at a center frequency of 1100 kilocycles. A typical i-f stage is shown schematically in figure 4-7. The i-f signal from the converter is fed through a transformer (T-107) to the grid of the first amplifier tube (V-103). Here it is amplified and fed through another transformer (T-108) to the grid of the second amplifier tube (V-104). This process is repeated through a second series of transformer T-109 amplifier tube V-105, and transformer T-110 to the detector tube. Tuning of the transformers is accomplished by adjustment of the iron cores within the primary and secondary windings. The stage gains and selectivity characteristics of the i-f amplifier are shown in figure 6-25. Essentially flat-topped response characteristics are obtained by resistance loading the secondary circuit of each transformer. The load resistor R-112 for the transformer T-108 is shown in figure 4-7. In the case of the last transformer T-110, the diode load resistor R-119 in figure 4-8 also serves as the load for the secondary circuit of the transformer T-110.

The gain of the radio receiver is controlled by varying the cathode bias on two i-f amplifier tubes V-103 and V-104 and on the converter tube V-102, by means of the "RECEIVER GAIN" control (R-110). When the

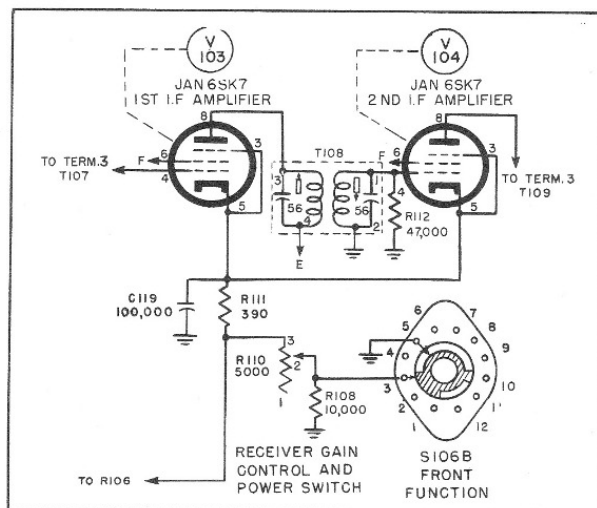


Figure 4-7. I-F Amplifier Circuit—Schematic

radio receiver is operating, the arm of this control is returned to ground through a section of the "FUNCTION" switch (S-106-B). In "FUNCTION" switch positions "4" and "5," (at which the radio receiver does not operate), a resistor (R-108) is inserted in the cathode circuits of the gain controlled tubes, thus increasing the cathode bias to cut off these tubes.

(4) SECOND DETECTOR.—One-half of the double triode tube (V-106) is connected as a diode (V-106-B) and used as a diode detector. (See figure 4-8). The i-f pulses from transformer (T-110) are rectified by this diode, and appear as video pulses across the load resistor (R-119). A capacitor (C-123) filters the i-f frequency component of the signal to ground. Since the load represented by the diode on the secondary of the transformer (T-110) may be represented by a resistor of approximately half the value of the diode load resistor R-119, the load is approximately 50,000 ohms, which is

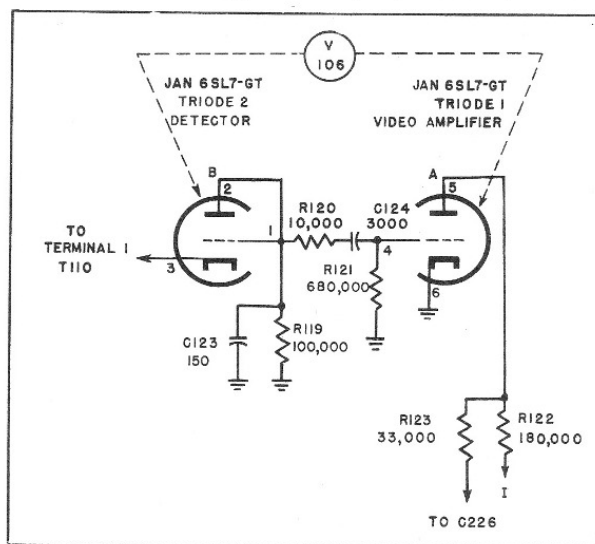


Figure 4-8. Second Detector and Video Amplifier Circuit—Schematic

substantially the same load used on the other i-f transformer secondaries.

(5) VIDEO AMPLIFIER.—The video output of the diode detector is coupled through a high pass filter consisting of a capacitor C-124 and a resistor R-121 to the grid of the second half of the double triode tube V-106, which is used as a triode amplifier for the video signals. The filter serves to eliminate, by limiting the low frequency response of the video amplifier, low frequency *splashes* which would cause the trace on the indicator screen to bounce. The signal is amplified by the video amplifier V-106-A, and fed through a second filter consisting of a resistor R-123, a capacitor C-226, and a resistor R-297 (not shown on figure 4-8), from which it passes to pin 10, the upper vertical deflection plate of the cathode ray indicator tube V-133. The high frequency response of the video amplifier is limited by the stray capacitance to ground of the wiring, the components of the plate circuit, and the coupling capacitor to the indicator tube deflection plate, which loads the effective plate impedance of the video tube.

b. TIMER UNIT CIRCUITS.

(1) GENERAL.—The timer employed in Receiver-Indicator R-65/APN-9 is controlled by a crystal oscillator which oscillates continuously at a frequency at or near 100,000 cycles per second. The entire timer serves to produce output pulses which, by switching, may be adjusted according to the following time intervals (one-half the equipment recurrence intervals).

Time Interval PRR L (Microseconds)	Station Rate	Time Interval PRR H (Microseconds)
20,000	0	15,000
19,950	1	14,950
19,900	2	14,900
19,850	3	14,850
19,800	4	14,800
19,750	5	14,750
19,700	6	14,700
19,650	7	14,650

By means of the "DRIFT" control, the selected time interval may be adjusted, over a narrow range, to equal exactly the recurrence interval of the pulses received from an external source. The "LEFT-RIGHT" switch allows instantaneous changing of the time interval to bring the starting point of the cycle into coincidence with that of the pulse received from an external source. During the time it is held to the right or left, this switch changes the recurrence interval. Thus, by properly using this switch and the "DRIFT" control, the cycle may be synchronized in phase with an external time base.

The timer also produces intermediate pulses for which the time intervals are shorter. The intermediate pulses are used to subdivide the time base to allow the accurate indication of the exact time interval between two specific instants of a complete cycle.

The timer unit consists of the following circuits which are described in the paragraphs indicated:

Circuit	Paragraph
100-kilocycle oscillator	4b(2)(a)
10-microsecond timer	4b(2)(e)
50-microsecond timer	4b(2)(f)
100-microsecond timer	4b(2)(g)
500-microsecond timer	4b(2)(h)
1,000-microsecond timer	4b(2)(i)
5,000-microsecond timer	4b(2)(j)
15,000-20,000-microsecond timer	4b(2)(k)

The starting time of a timer interval is defined as the firing time of the 10-microsecond blocking oscillator which would be coincident with the firing times of all successive blocking oscillators provided no time delay occurred in the system.

(2) CIRCUITS.

(a) 100 - KILOCYCLE CRYSTAL OSCILLATOR.—The timing standard used in Receiver-Indicator R-65/APN-9 is an oscillator controlled by a 100-kilocycle crystal Y-101. All the functions of the timer, delay, and deflection circuits derive their time bases directly or indirectly from this circuit.

Figure 4-9 shows the details of the crystal oscillator circuit schematically. One section of the double triode tube V-107 functions as a triode oscillator tube V-107-A. The grid circuit is composed fundamentally of the 100-kilocycle crystal Y-101 shunted by a variable capacitor C-127, which is the "DRIFT" control, and an inductance L-101. The 1-megohm resistor in the assembly with the inductance coil L-101 is the grid leak for the triode V-107-A and the 510-micromicrofarad capacitor is

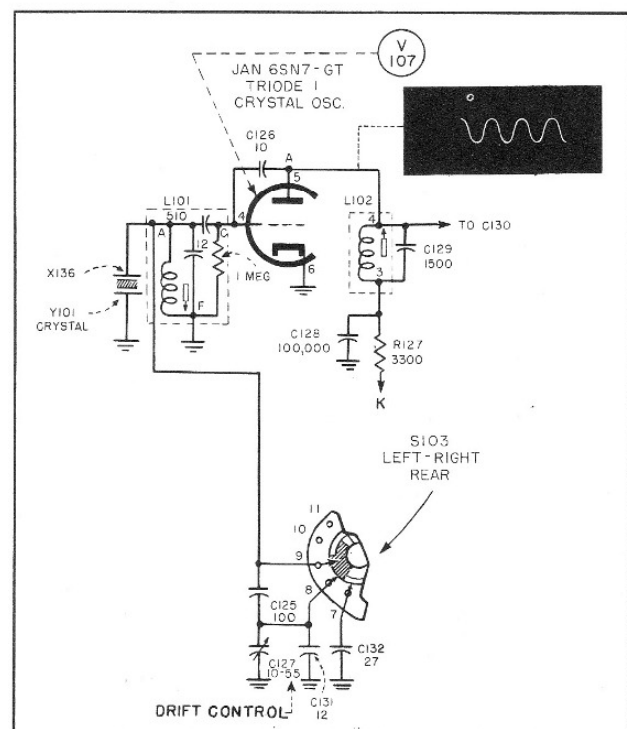


Figure 4-9. Crystal Oscillator Circuit—Schematic

microsecond blocking oscillator necessary to fire the 500-microsecond blocking oscillator. Therefore, during the feedback interval the number of steps required to fire the 500-microsecond blocking oscillator is reduced by one on "STATION" rates "2" and "3." The combination of two capacitors C-145 and C-146 is so adjusted that the 100-microsecond feedback counter produces a step which is equivalent to two steps of the 100-microsecond counter. This reduces by two the number of 100-microsecond pulses needed to fire the 500-microsecond blocking oscillator during the feedback interval on "STATION" rates "4" and "5." Similarly on "STATION" rates "6" and "7," three capacitors in combination (C-144, C-147, and C-143) are so adjusted that the number of 100-microsecond pulses required to fire the 500-microsecond blocking oscillator is reduced by three during the feedback interval.

Note that at the odd station rates, the 15,000 to 20,000-microsecond oscillator is loaded by both feedback counters, causing a slight reduction in its output voltage. Therefore, the steps produced by the 100-microsecond feedback diode will be slightly smaller at the odd station rates than at the corresponding even station rates. This fault is eliminated on "STATION" rates "3" and "5" by adding a small capacitor C-234 (not shown in figure 4-18) in parallel with the respective feedback networks. At "STATION" rate "7," a separate capacitor C-237 is used for this purpose.

A review of the variations effected by the feedback circuit shows that the required lengths are established for the feedback intervals as described in the beginning of this paragraph. When the "LEFT-RIGHT" switch is held to "RIGHT" with the "FUNCTION" switch in position "1," the capacitor C-128 (not shown in figure 4-18) is so adjusted that the charge placed on the grid storage capacitor C-141 will be increased by one step at all station rates, which in effect changes the station rates as indicated below:

Normal "STATION" Rate	"STATION" rate indicated with "FUNCTION" switch in position "5" and "LEFT-RIGHT" switch turned to "RIGHT"
0	2
1	3
2	4
3	5
4	6
5	7
6	8*
7	9*

(*) Indication of additional station rate numbers at present not assigned in the system.

(i) 1000-MICROSECOND TIMER.—The circuit for this timer, as shown in figure 4-19, includes the 500-microsecond counter and the 1000-microsecond blocking oscillator. The circuit is similar to that of the 100-microsecond timer except that the feedback circuit has been omitted. This simplification, together with the low count required from this stage, allows the use of a fixed cathode potential. The circuit receives the pulses from the 500-microsecond blocking oscillator and fires on alternate pulses so that the output pulse inter-

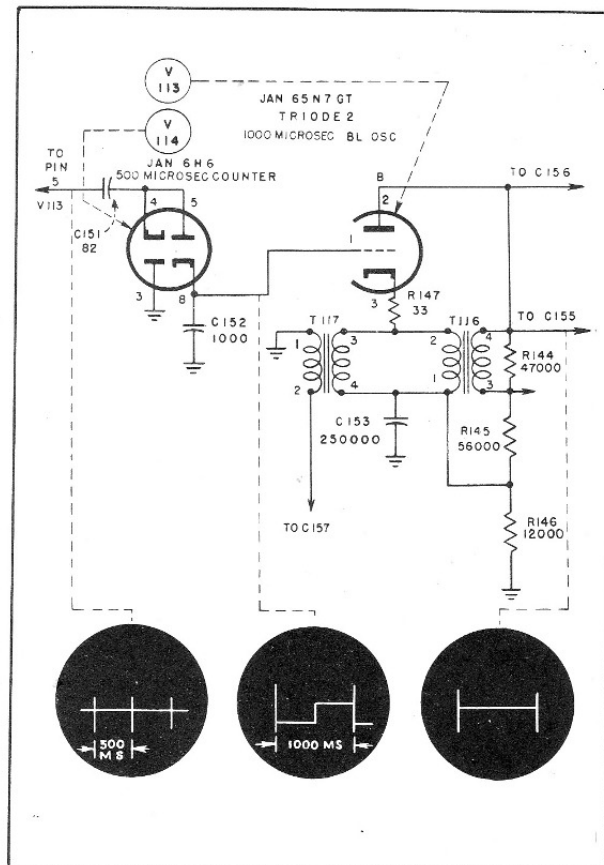


Figure 4-19. 1000-Microsecond Timer
Circuit—Schematic

val equals two input pulse intervals. The counter is operated by a pulse voltage that first swings negative, then positive and, therefore, functions as the type of counter circuit described in paragraph 4b(2)(d)2, this section. The pulses from the 1000-microsecond timer are used at positions "4" and "5" of the "FUNCTION" switch to mark 1000-microsecond time intervals. An auxiliary pulse transformer (T-117) is used to reverse the polarity of pulses for indication in the fifth "FUNCTION" switch position. The circuit also provides synchronizing pulses for the 5000-microsecond timer.

(j) 5000-MICROSECOND TIMER.—The circuit for this timer, as shown in figure 4-20, includes the 1000-microsecond counter and the 5000-microsecond blocking oscillator. The circuit is similar to that of the 100-microsecond timer except that the feedback circuit and the auxiliary pulse transformer are omitted. The circuit receives the pulses from the 1000-microsecond blocking oscillator and fires on every fifth pulse, so that its output pulse interval equals five input pulse intervals. The counter is operated by a pulse voltage that first swings negative, then positive, and, therefore, functions as the type counter circuit explained in paragraph 4b(2)(d)2, this section. The pulses from the 5000-microsecond

(2) CIRCUITS.—The system consists of the following circuits which are described in the paragraph indicated:

Circuit	Paragraph
Pulse Rectifier, Eccles-Jordan Multivibrator and Cathode Follower	4c(2)(a)
Coarse Delay Multivibrator	4c(2)(b)
Fine Delay Multivibrator	4c(2)(c)
Differential Mixer	4c(2)(d)
Slow Sweep Amplifier	4c(2)(e)
Fast Sweep Amplifier	4c(2)(f)
Horizontal Amplifier	4c(2)(g)
DC Restorer	4c(2)(h)
Amplitude Balance	4c(2)(i)
Marker Mixer	4c(2)(j)

(a) PULSE RECTIFIER, ECCLES-JORDAN MULTIVIBRATOR, AND CATHODE FOLLOWER.—These circuits, as illustrated in figure 4-23, are used to transform the output pulse voltage of the last blocking oscillator of the timer circuit into an essentially square wave form. One triode of tube V-118-B is connected as a diode which serves to rectify the incoming pulses and produces unidirectional negative pulses for triggering the square wave generator. The two triodes of the tube (V-119-A and V-119-B) with their associated parts are arranged symmetrically to form a pulse-excited oscillator circuit, based on the Eccles-Jordan type trigger circuit. The reciprocating action of this circuit generates the square waves. One triode of a tube (V-120-B) is connected as a cathode follower, and is used to couple the output of the square wave generator to subsequent circuits without loading the Eccles-Jordan multivibrator circuits.

The output pulse as supplied from the last blocking oscillator consists of the negative power pulse

and the positive pulse tail. Rectification of the output pulse to give it unidirectional negative voltage is accomplished by using the tube (V-118-B) as a diode and connecting the output of the last blocking oscillator to its cathode. The rectified voltage output is obtained from the plate. Since the pulse rectifier can only conduct a current from plate to cathode, it is evident that the positive pulse tail will not pass into the plate circuit.

Referring to the Eccles-Jordan trigger circuit, the grid of each of the triodes of the tube (V-119) is coupled to the plate of the other triode, so that the operation of the halves of the circuit are mutually dependent. Only one triode at a time can draw current since the conducting triode cuts off the other triode, and this condition continues until upset by application of a triggering pulse to the grids. When a negative pulse is applied to the grids, the operation of the tubes is suddenly reversed, cutting off the triode which had been drawing current, and allowing the triode which had been idle to conduct. This process is repeated at each triggering pulse. Thus, the voltage across the plate load resistors jumps alternately from a high to a low value, thereby producing an essentially square wave form.

As shown in figure 4-23, each of the grids of the tubes (V-119-A and V-119-B) are coupled to the source of the triggering pulses through resistor-capacitor networks (R-178 and C-170, and R-177 and C-169 respectively). Two sets of resistors (R-175 and R-179, and R-180 and R-176) form voltage dividers which place about 20 percent of the voltage of each plate on the opposite grid. Two capacitors (C-168 and C-171) serve to increase this ratio for the high frequency AC components of the plate voltages, which occur during the shifting period. A resistor and capacitor R-174 and C-172 provide a common cathode bias and bypass for both

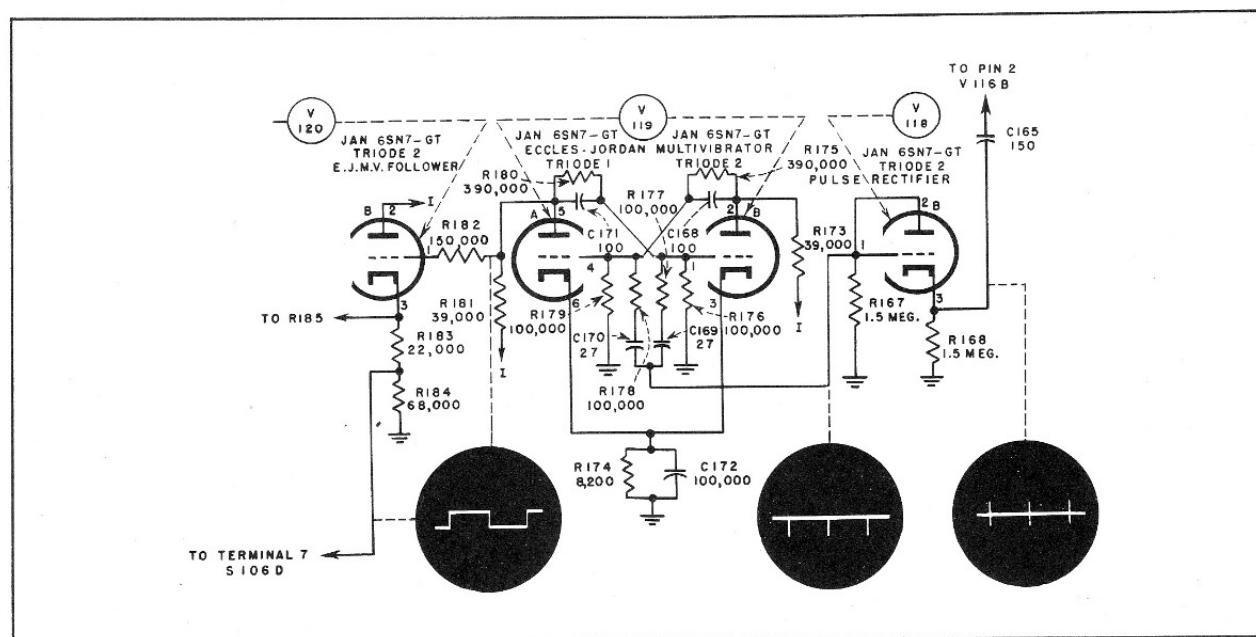


Figure 4-23. Pulse Rectifier, E. J. Multivibrator and Cathode Follower Circuits—Schematic

triodes. Two resistors R-173 and R-181 are used in the plate circuits.

In explaining the exact functioning of the circuit, it is assumed that the power is off and the entire tube V-119 is idle. When power is applied to the circuit, either half of the tube may begin to draw current before the other half due to an unbalance of tube characteristics or components. Assuming that triode 2 (V-119-B) is the first to begin drawing current, the current flowing through the plate resistor R-173 causes a drop in the plate voltage and consequently the portion of this voltage appearing on the grid of triode 1 (V-119-A) drops, or becomes less positive. This causes in turn, a decrease in any plate current that triode 1 might draw, with the result that its plate voltage will rise and consequently the grid voltage of triode 2 becomes more positive, resulting in a further increase of the current drawn by triode 2 and the consequent decrease of plate voltage and grid voltage on triode 1. This cycle continues until the grid voltage on triode 1 is driven to such a value below the cathode voltage as to bias triode 1 beyond the cutoff point. At this stage, the circuit becomes stable with triode 1 idle and triode 2 drawing a steady current according to the constants of its plate, grid, and cathode circuits. It should be noted that the regenerative process described above takes place in a very short time.

When a negative triggering pulse is received from the pulse rectifier, it is applied simultaneously to both grids. Since the grid of triode 1 is already negative with respect to its cathode, no initial action results in this tube. The grid of triode 2, however, which has been established at a positive potential is suddenly driven negative. The heavy plate current drawn by triode 2 is thereby sharply reduced, causing a sudden rise in plate voltage, which is transmitted through the capacitor C-168 to the grid of triode 1. Since this plate voltage change is considerably larger than the negative pulse supplied to the grid of triode 1 by the triggering pulse, the negative grid cathode potential will be reduced sharply. This allows plate current to flow in triode 1, producing a drop in the plate voltage of this triode, with a consequent drop in the grid voltage of triode 2 by which its grid potential is driven further negative with respect to its cathode. The action is cumulative and results in triode 2 being cut off, and the circuit becoming stable with triode 1 drawing a constant plate current until the next triggering pulse arrives. At the arrival of each triggering pulse the above process is repeated, thereby reversing the action of the tubes and producing an output voltage of essentially square wave form.

The output of the square wave generator is fed through the cathode follower tube V-120-B which serves two functions: the load presented by subsequent circuits is prevented from unbalancing the circuits of triodes 1 and 2 of the tube V-119 and, without appreciable loss or gain, a low impedance output source is provided which can be loaded relatively heavily without distortion of the desired square wave shape.

(b) COARSE DELAY MULTIVIBRATOR.—As illustrated by the idealized wave shapes in figure 4-24,

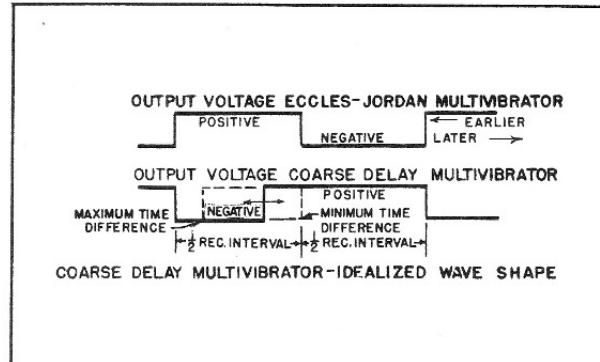


Figure 4-24. Coarse Delay M. V. Wave Shape

this circuit serves to provide long rectangular negative pulses of variable duration. The initiation of a negative pulse of the coarse delay multivibrator is controlled by and synchronized with the positive swing of the Eccles-Jordan multivibrator cathode follower output. The duration of this negative pulse is shorter or, at most, equal to one-half the recurrence interval, and is controlled in steps of 500 microseconds by the setting of the "COARSE DELAY" control so that the time difference, which is determined by subtracting the length of the negative pulse from one-half the recurrence interval, may be changed from zero to more than 10,000 microseconds. The end of the negative pulse controls the starting time of a cycle of the fine delay multivibrator as explained in paragraph 4c(2)(c).

Figure 4-25 shows a simplified circuit diagram and other operational features. Essentially, the circuit consists of two resistance coupled triode amplifiers having a common cathode resistor. The operation of a circuit of this type alternates between a stable and a semi-stable condition. Thus, while triode 1 of the tube V-123-A is conducting a plate current, the control grid voltage of triode 2 (V-123-B) may be of such value as to cut off this second triode as indicated at B in figure 4-25. Since the grid leak for triode 2 is connected to plate supply voltage through a high resistance the control grid conducts a weak current, maintaining its potential slightly positive with respect to the cathode, and since the plate and cathode currents are almost equal, corresponding cathode and plate voltages for triode 1 may be calculated and plotted as indicated in D in figure 4-25. Referring to the operating characteristics of one-half of a 6SN7GT tube, the stable plate current of triode 1 is calculable since the grid to cathode voltage is almost zero, the plate supply voltage and the plate and cathode resistances are known.

With triode 1 cut off, the effective part of the circuit is shown as indicated at C in figure 4-25, with the stable operating condition controlled by the setting of the "COARSE DELAY" control (R-209). Again referring to the operating characteristics of one-half of a 6SN7GT tube, a curve is developed which indicates the control grid voltage required to produce a desired cathode current in triode 2. The curves of the plate, cathode,

voltage decreases is faster for smaller capacitor and resistor values.

The above explanation applies also to the start of a negative pulse, except that the differentiated pulse will be negative. The entire coarse delay multivibrator circuit is shown in figure 4-27 with all pertinent wave shapes. The principal differences between the simplified diagrams and the complete circuit diagram are outlined below:

A resistor-capacitor network (R-215 and C-187) is inserted between the plate of triode 2 and the control grid of triode 1. The resistor is used to avoid driving the control grid of triode 1 unduly positive during the change-over period. The capacitor is added to eliminate time delay in transferring a plate voltage change from triode 2 to the control grid of triode 1.

The successive negative pulses produced by the coarse delay multivibrator must have exactly the same time spacing. To insure this, the control grid of triode 2 is supplied both with differentiated Eccles-Jordan multivibrator pulses through the capacitor C-184, and with 500-microsecond pulses through the capacitor C-188. The effect of these latter pulses is as follows: When triode 2 is non-conducting, the pulses will have no effect since their amplitude is insufficient to cause the tube to conduct a current. When triode 2 conducts, the pulses are amplified, and the amplified pulses are superimposed on the rising grid voltage, causing the grid voltage to be slightly raised every 500 microseconds. Thus, the change-over, which occurs when the grid potential reaches a value at which plate current flows in triode 1, will be accurately timed to take place in steps of 500 microseconds.

Since only a small fraction of the total voltage across the bleeder is required for the operation of the equipment, the range of the "COARSE DELAY" control circuits requires close adjustment. Furthermore, if the control grid voltage is raised to a potential which results in a negative output pulse equal to one-half the recurrent interval, the negative pulse provided by the Eccles-Jordan multivibrator terminates the negative output pulse. The required pulse lengths differ for the two pulse recurrent rates, and are as follows:

PRR	Approximate Length (Microseconds) of Negative Pulse	
	Minimum	Maximum
L	6,000	20,000
H	3,000	15,000

For this reason, separate adjustments are provided for each of the pulse recurrence rates to control the duration of the negative pulse as specified above. A resistor R-166 controls the minimum grid voltage when the "PRR" switch is set at "H," while another resistor R-165 performs the same function when the "PRR" switch is set at "L." The voltage across the "COARSE DELAY" control resistor (R-209) is adjusted by resistor (R-210) to provide the correct maximum duration with the "PRR" switch at "H." This last adjustment is not changed when

the "PRR" switch is turned to "L," but the wider range of adjustment is provided by the variable grid series resistor (R-217). The output wave of the coarse delay multivibrator from the plate of triode 2 is fed to the fine delay multivibrator.

The above text has demonstrated that the coarse delay multivibrator may be made to operate as a reciprocal-action oscillator, since the circuit has one stable and one semi-stable operating condition, and that the circuit will complete one cycle by regenerative action each time it is triggered by external means. When the control grid potential of triode 1 cuts this tube off, triode 2 conducts current. However, grid leak resistor R-216 will increase this voltage and the current will shift to triode 1 at the time of a 500-microsecond pulse. If the time interval required to charge capacitor C-186 is longer than half the recurrence interval, the negative pulse derived from the Eccles-Jordan multivibrator output will effect the change-over at that time. When triode 1 is drawing current, a positive pulse from the Eccles-Jordan multivibrator shifts the current over to triode 2.

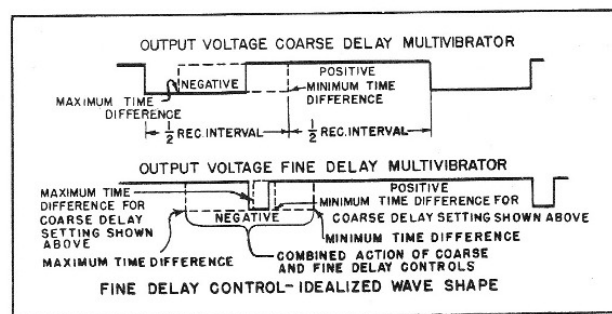


Figure 4-28. Fine Delay Multivibrator Pulses

(c) FINE DELAY MULTIVIBRATOR.—The fine delay multivibrator, with its associated clipping circuit, is controlled by the coarse delay multivibrator. It provides negative rectangular pulses of variable duration as illustrated in idealized form in figure 4-28. The end of a negative pulse from the coarse delay multivibrator will be coincident with the start of a negative pulse from the fine delay multivibrator. The minimum duration of the pulse is approximately 400 microseconds and its maximum duration is approximately 1400 microseconds.

The end of the negative output pulse of the fine delay multivibrator, therefore, may be continuously adjusted by means of the "COARSE DELAY" and "FINE DELAY" controls to occur at any desired point within the combined ranges of the two controls.

By referring to figure 4-29, it may be noted that the fine delay multivibrator operates essentially according to the same principles as the coarse delay multivibrator, the foregoing description of which would, therefore, apply also to this circuit. The fine delay multivibrator is triggered by the negative pulses from the coarse delay multivibrator which are fed through the differentiating capacitor-resistor network C-190 and R-223. The control grid voltage in triode 2 of tube V-124 may be varied

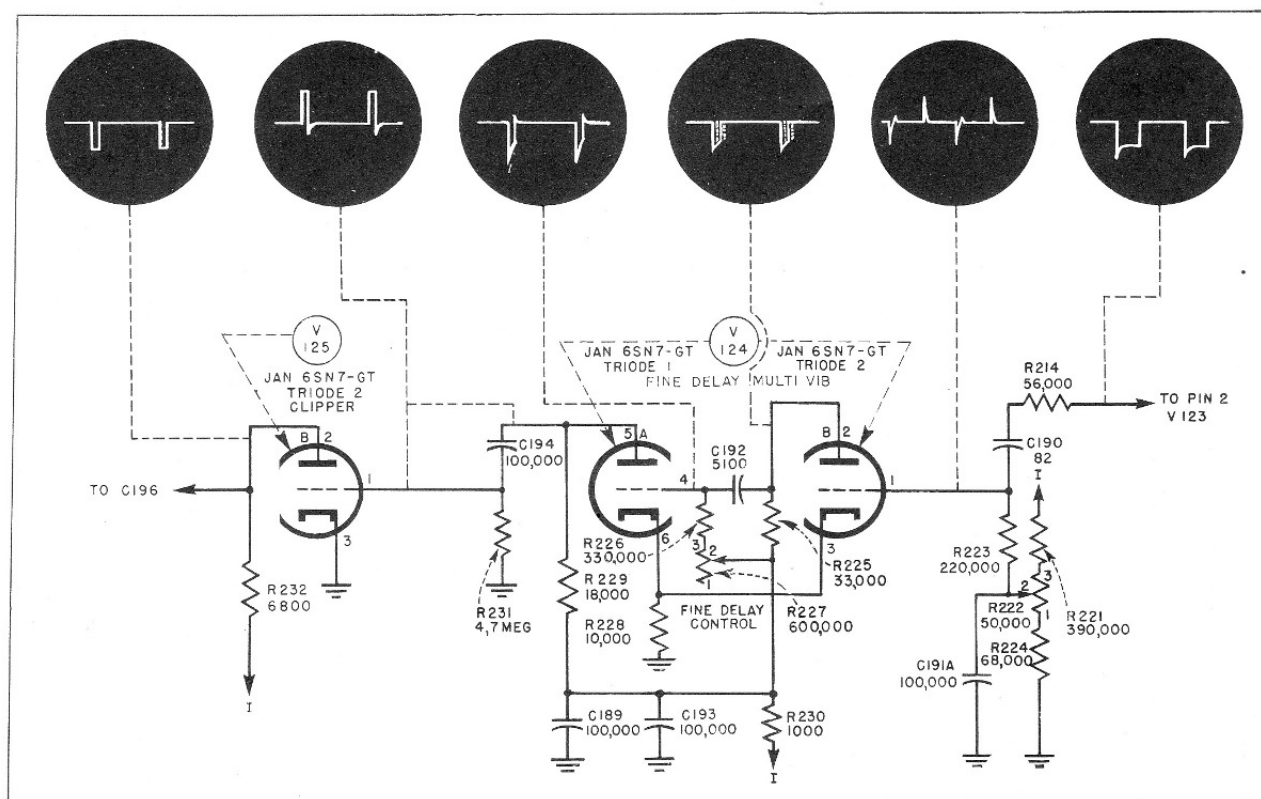


Figure 4-29. Fine Delay Multivibrator-Circuit—Schematic

by means of potentiometer R-222 which serves to set the operating bias of this tube and, therefore, partially determines the duration of the negative pulse from the fine delay multivibrator. The grid coupling network of triode 1 serves the same purpose as for the coarse delay circuit, except that the capacity of coupling capacitor C-192 and the resistance of grid leak resistors R-226 and R-227 have been substantially reduced to facilitate the quicker change-over required here. The value of the grid leak resistance may be varied over an approximate range of 3:1, thus permitting the operator to change the duration of the pulse in this ratio. This control is the "FINE DELAY" control on the front panel. Resistor R-222 is a screw driver adjustment control used to adjust the range covered by the "FINE DELAY" control.

The output of the fine delay multivibrator is taken from the plate of triode 1 and is fed to a clipper circuit consisting of one triode of a tube JAN-6SN7-GT (V-125-B). The function of this circuit is to transform the somewhat irregular pulse into a more rectangular form. The operation of the circuit is as follows: Capacitor C-194 is charged by the input pulse to the peak voltage of the pulse, since triode V-125-B conducts a grid current whenever the grid potential becomes positive. At large values of capacitor C-194 and resistor R-231, the voltage across the capacitor will change relatively little between consecutive pulses. Consequently, only the top portion of the positive pulse wave will be amplified with the triode V-125-B being idle the remainder of the time.

(d) DIFFERENTIAL MIXER.—The differential mixer combines the square wave output of the Eccles-Jordan multivibrator with the rectangular pulse output of the fine delay multivibrator and produces identical output pulses from both sources. The leading edges of consecutive output pulses correspond in time with the start of the positive swings of the Eccles-Jordan multivibrator wave and the fine delay multivibrator wave, respectively, thus the interval between these pulses is determined by the setting of the "COARSE DELAY" and "FINE DELAY" multivibrator controls. Besides triggering the fast sweep generator, these output pulses are used, at "FUNCTION" switch positions "1" and "4," as delay indication markers on the indicator screen. The circuits, together with the principal wave forms, are schematically shown in figure 4-30. The input waves, shown at E and C, are fed through two identical differentiating networks (C-199 and R-239, and C-196 and R-235) to the grids of triode 1 and triode 2, respectively, of tube V-126. The differentiating process, as previously explained in paragraph 4c(2)(b), produces sharp pulses as shown at D and B having leading edges which correspond in time with the leading edges of the two rectangular waves which feed the differentiating circuits. Triode 1 and triode 2 are connected identically and are cathode-biased slightly beyond their cutoff value from their bleeders (R-240 and R-241, and R-236 and R-237, respectively). Since the tubes are normally cut off, the negative pulses have no effect on the grids, and only the positive pulses of waves D and B control their operation.

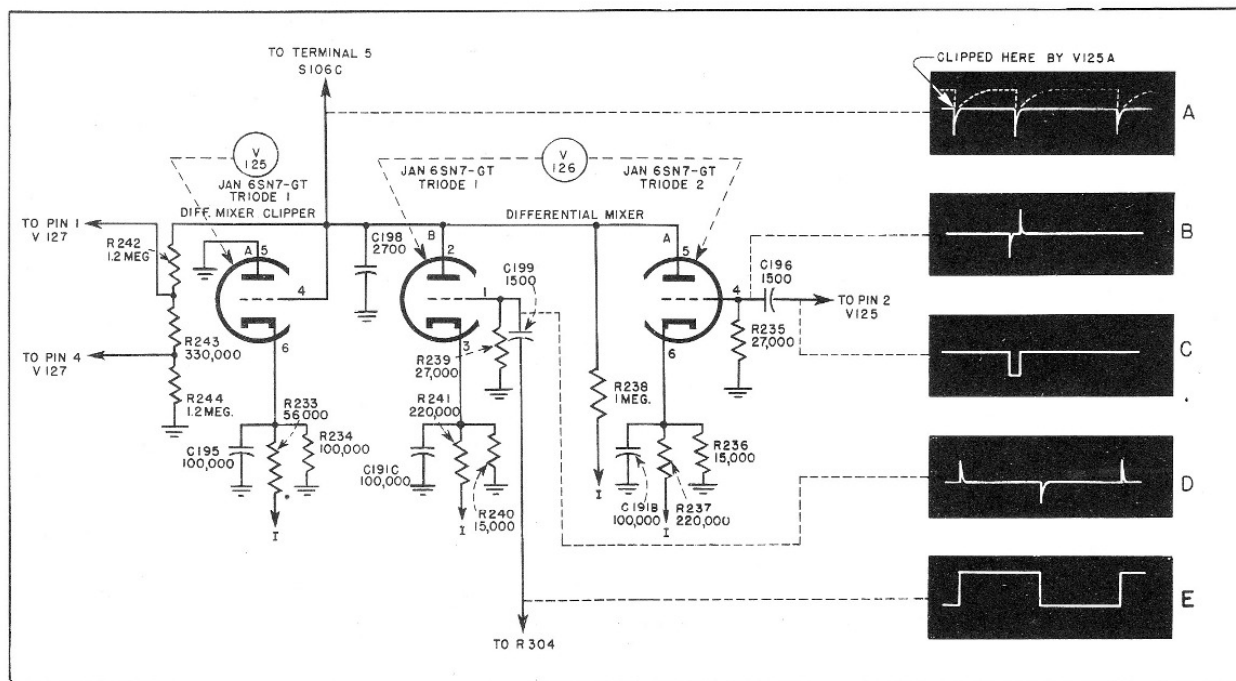


Figure 4-30. Differential Mixer-Circuit—Schematic

By the application of the input pulses, the grids of both triodes are driven to a positive potential which is comparable to the instantaneous plate potential, thus effecting operation at a point on the plate characteristics such that normal amplification does not occur; and the amplitude of the pulses appearing at the plates of both triodes is substantially independent of the amplitude of the driving grid pulses, and is equal for both triodes. The voltage produced by both triodes consists of sharp negative pulses, of equal amplitude, corresponding in starting time with the positive pulses of wave forms C and E. These pulses sharply discharge capacitor C-198 in the plate circuit to a potential independent of the amplitude of the grid pulses. Capacitor C-198 is then recharged through resistor R-238 at a rate determined by the values of capacitor C-198 and resistor R-238 which fix the time constant of the circuit. The shape of the charging curve is exponential, and, if it were not for the clipping action of the clipper triode (V-125-A) the shape would follow a curve similar to that indicated by the dotted lines in A.

Clipper V-125-A is operated as a diode with its cathode biased from the bleeder (R-233 and R-234) to a positive potential, and its grid directly coupled to the plates of triodes 1 and 2 of tube V-126. Thus, both grid and cathode are positive in relation to ground. During the extreme negative swing of the applied pulses from the plates of triodes 1 and 2 (V-126), the cathode is at the higher potential, thus maintaining a negative grid to cathode bias. A point occurs during the charging cycle of capacitor C-198 following the negative peak, at which the grid potential reaches the level of the cathode potential; at this point the clipper (V-125-A) begins to draw grid current. Thus, the maximum potential of the grid is limited by the value of the cathode potential. This results in the clipping action indicated by the solid line in A,

thus eliminating a part of the exponential portion of the charging curve. This sets the plate potential of triodes 1 and 2 of V-126 at a constant level between pulses. The plate of V-125-A is returned to ground rather than tied to the grid in order to prevent undue coupling to the elements of the other clipper triode (V-125-B). Elimination of the exponential portion of the wave also permits operation at a shorter time interval between pulses with the leading pulse in no way affecting the shape of the succeeding pulse.

Therefore, the output wave form consists of negative pulses having sharp leading edges separated by a time interval equal to that between the starting times of the positive swing of the Eccles-Jordan multivibrator output wave and the positive swing of the fine delay multivibrator output wave. All pulses are of an equal amplitude, as determined by the action of the triodes (V-126-A and V-126-B), and the wave form and time interval remains constant as determined by the action of the capacitor-resistor combination C-198 and R-238, and the clipping action of the clipper triode V-125-A. Three resistors (R-242, R-243, and R-244) form a voltage divider which feeds portions of the output voltage to the fast sweep generator.

(e) SLOW SWEEP GENERATOR.—The slow sweep generator serves to develop a sawtooth voltage wave which is used to produce horizontal deflection on the indicator screen at "FUNCTION" switch positions "1" and "4." The generator is controlled by the output pulses from the final blocking oscillator of the timer circuit and produces triangular output waves of a duration equal to the intervals between pulses of the timer output, hence, equal to half the repetition interval of the LORAN signal pulses.

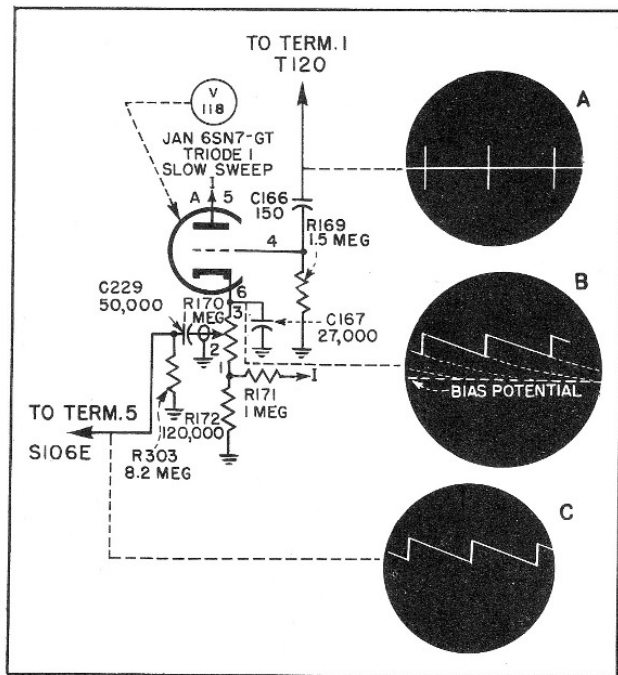


Figure 4-31. Slow Sweep Generator-Circuit—Schematic

Figure 4-31 shows schematically the circuits involved and the principal wave forms. Triode V-118-A is operated with the cathode biased from the voltage divider (R-171 and R-172) to a value beyond cutoff. Thus, under static conditions, capacitor C-167 is charged to the cathode potential, and no cathode current flows. Sharp output pulses of the timer (shown at A) are fed through capacitor C-166 to the grid of the triode (V-118-A). Since this triode is biased beyond cutoff, only a portion of the positive half of the wave at A affects operation, causing cathode current to flow when the grid potential rises above its cutoff value. The sudden flow of current sharply increases the cathode potential and the charge on capacitor C-167. This period of charging is short and ends when the positive grid pulse falls below the point of cutoff. The capacitor then starts to discharge and approach its former potential at a rate determined by the values of the capacitor-resistor network C-167 and R-170), which fix the time constant of the circuit. Before completion, the discharge period is interrupted by the succeeding positive grid pulse, which again sharply charges the capacitor, and the cycle repeats. Since both the charging and discharging of the capacitor are interrupted before completion, only a portion of the exponential charging curves are utilized, and these portions are approximately linear. Thus, the wave form appearing at the cathode is a sawtooth shape as shown at B. The dotted lines indicate the curve the wave shape would assume if the charging cycle were allowed to go to completion. At "FUNCTION" switch positions "1" and "4," a portion of the cathode voltage thus developed is fed from the arm of potentiometer R-170, which is the "SLOW SWEEP AMPL." control, through capaci-

tor C-229 to the grid of the horizontal amplifier. Resistor R-303 is the grid leak for the following triode. The time constant of the capacitor-resistor network (C-229 and R-303) is such that the wave shape is not affected by them and appears at the grid of the horizontal amplifier with essentially the same shape (as shown at C) as at the cathode of the triode (V-118-A).

(f) FAST SWEEP GENERATOR.—The fast sweep generator produces pulses having a double slope and other wave shapes used for horizontal deflection and blanking of the indicator tube traces at "FUNCTION" switch positions "2," "3," "5," and "6." The required shape of the double slope waves consists of a steep slope at the start which expands the left, or starting end of the indicator trace, and a lesser slope which compresses the remainder of the trace. Both slopes are approximately linear, and the total duration of each sweep is about 1400 microseconds, the steep portion occurring in the first 100 microseconds. The fast sweep is controlled by the output of the differential mixer, producing pulses of identical shapes which are spaced at intervals corresponding to the leading edges of the controlling pulses provided by the differential mixer. Thus the timer interval between corresponding points of successive fast sweep waves is determined by the setting of the "COARSE DELAY" and "FINE DELAY" controls. The circuits also provide the voltages for blanking the indicator tube during operation with the fast sweep.

Figure 4-32 schematically shows the circuits involved and the principal wave shapes. Triode 1 (V-127-A) produces by means of its cathode coupled circuit the lesser slope of the wave and thus, the slow portion of the sweep. From a portion of its cathode circuit, triode 2 (V-127-B) produces the steep slope for the expanded portion of the sweep and from its plate circuit, the blanking pulses. The grid of triode 1 is directly coupled to the plate circuit of the differential mixer through a voltage divider network, and it receives a portion of the output signal as shown at A, figure 4-32. The grid of triode 1 is positive with respect to ground, but the plate current drawn by this triode develops a cathode voltage somewhat greater than the grid potential, and the grid is, therefore, negative with respect to the cathode. In the absence of pulses, a steady state potential exists at the cathode and across capacitor C-204. When negative pulses are applied as at A, the grid is driven beyond the cutoff value during a large portion of the pulse duration. During the period of cutoff, triode 1 draws no current, and capacitor C-204 is discharged through resistor R-247 at a rate determined by the time constant of resistor and capacitor. This time constant is long compared to the cutoff interval, and the discharge cycle is interrupted before completion; consequently, the grid returns to its steady state potential at a value above the cutoff point. Capacitor C-204 is then recharged through triode 1 at a much faster rate, determined primarily by the internal resistance of this triode. The resulting cathode voltage appearing across the resistor-capacitor (R-247 and C-204) is shown at B.

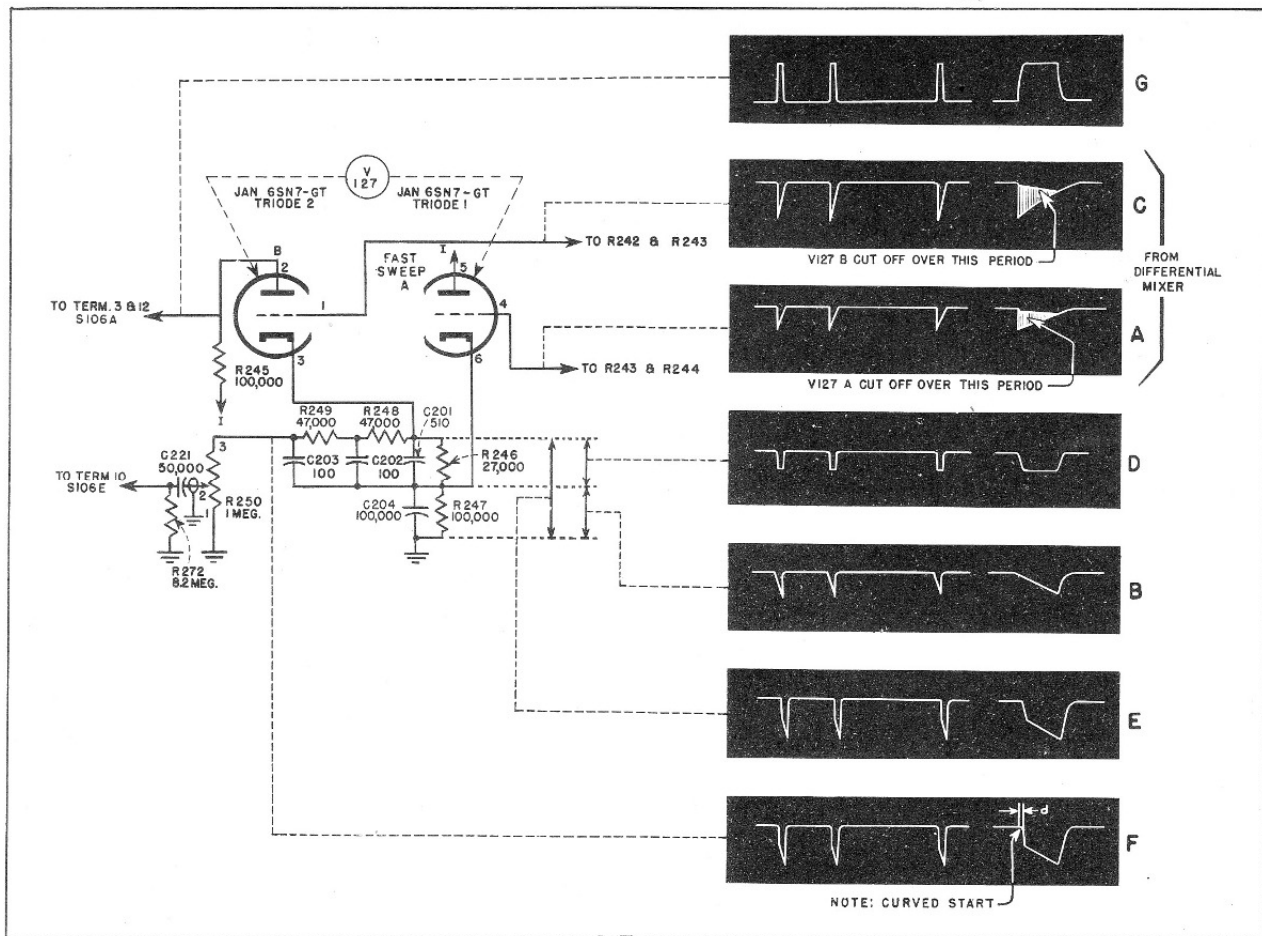


Figure 4-32. Fast Sweep Generator-Circuit—Schematic

The grid of triode 2 is also directly coupled to the plate circuit of the differential mixer, but to a somewhat higher potential point on the output voltage divider, and receives a signal as shown at C, which differs from that at A only by its greater amplitude. Triode 2 also normally draws plate current developing a cathode bias through resistors R-246 and R-247, and charging capacitor C-201 to a fixed fraction of the steady state cathode potential. When the negative signals of C are applied to the grid, triode 2 is cut off during part of the pulse duration. During the cutoff period, capacitor C-201 discharges through resistor R-246 at a rate determined by the time constant of the capacitor and resistor. As this time constant is short compared to the cutoff period, complete discharge occurs in the early part of this period. No further action occurs until the grid returns to a value above the cutoff point and triode 2 again draws current. When triode 2 draws current, capacitor C-201 is recharged through resistor R-246 to its original potential. The resulting voltage developed across the capacitor-resistor combination (C-201 and R-246) is shown at D.

Since capacitor C-201 discharges during the cutoff period, lowering the cathode potential of V-127-B to a potential equalling that across capacitor C-204, which

is also varying, the voltage developed at the cathode of triode 2 is the sum of the voltages appearing across capacitors (C-201 and C-204). This voltage wave, shown at E, is thus the sum of B and D and consists of a steeply sloping leading edge, developed by the rapid discharge of capacitor C-201, and an abrupt change to a more gradual slope developed by the discharge of capacitor C-204. As the recharge period for both capacitors (C-201 and C-204) begins at approximately the same time, a steeply sloping return swing is imparted to the combined wave.

Referring to the expanded views of the applied grid pulses of waves A and C, it will be found that cutoff occurs at a different level on the negative and positive swings (noted by the sloping lines above the shaded cutoff period). The cathode potential changes during the cutoff period, changing the cathode bias, and placing the point of cutoff at the new level with respect to the grid potential. Due to the difference in the shape of the cathode voltage between triodes 1 and 2 during cutoff, the change in cutoff value is different for the two triodes, the greater difference being in triode 2. By applying a larger negative grid pulse to triode 2 than to triode 1, this effect is balanced so that the cutoff period for both triodes ends at nearly the same time; but triode 2 is always

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voltage to the grid of the indicator, illumination of the screen is provided only during the time intervals of the fast sweeps.

(g) **HORIZONTAL AMPLIFIER.**—The horizontal amplifier consists of a triode amplifier and a phase inverter, operating to provide a push-pull output from the sweep generators to the horizontal deflection plates of the indicator tube.

Figure 4-33 schematically shows the circuits involved and the wave forms of the principal voltages. Input voltages, shown at A and B, from the fast and slow sweep generators, respectively, are selected for application to the grid of the triode (V-135-B) by part of "FUNCTION" switch (S-106-E). Voltage B is applied in positions 1 and 4, and voltage A is applied in positions 2, 3, 5, and 6. The triode (V-135-B) is a normal triode amplifier and provides the output waves G and H when operating on the inputs A and B, respectively, which have been amplified and inverted in phase. The triode bias is controlled by its cathode current which flows through resistor R-273, and also at "FUNCTION" switch positions 1 and 4, from the +B supply through the voltage divider formed by resistors R-273 and R-274. This additional bias is removed at "FUNCTION" switch positions 2, 3, 5, and 6 by a switch section (S-106-E). Thus, this triode operates with a higher bias on input wave B than on A. This is required because the difference in wave shapes between A and B voltages places the *average* voltage at different levels with respect to the peaks in each case. Referring to wave A, the average voltage occurs at the level at which the magnitude and duration of the positive portion equals the magnitude and duration of the negative portion. These portions are indicated by opposite cross-hatched areas. Since the level of the average voltage must be such that the positive and negative areas are equal and since the

Blanking voltage for the indicator tube is taken from the plate circuit of the triode (V-127-B) and appears as shown at G. When this tube is cut off by the applied wave C, the plate current suddenly ceases, and the plate voltage rises to the $+B$ potential at a rate determined by the values of resistor R-245 and the stray capacity of the plate circuit. The plate voltage remains thus, until the grid swings positive to the point when plate current again flows, and a drop occurs across resistor R-245 reducing the plate potential. The duration of the positive plate pulse thereby produced is controlled by the duration of the cut-off period of the fast sweep triode 2 (V-127-B) and, hence, is the same as that of the fast sweep. By applying this

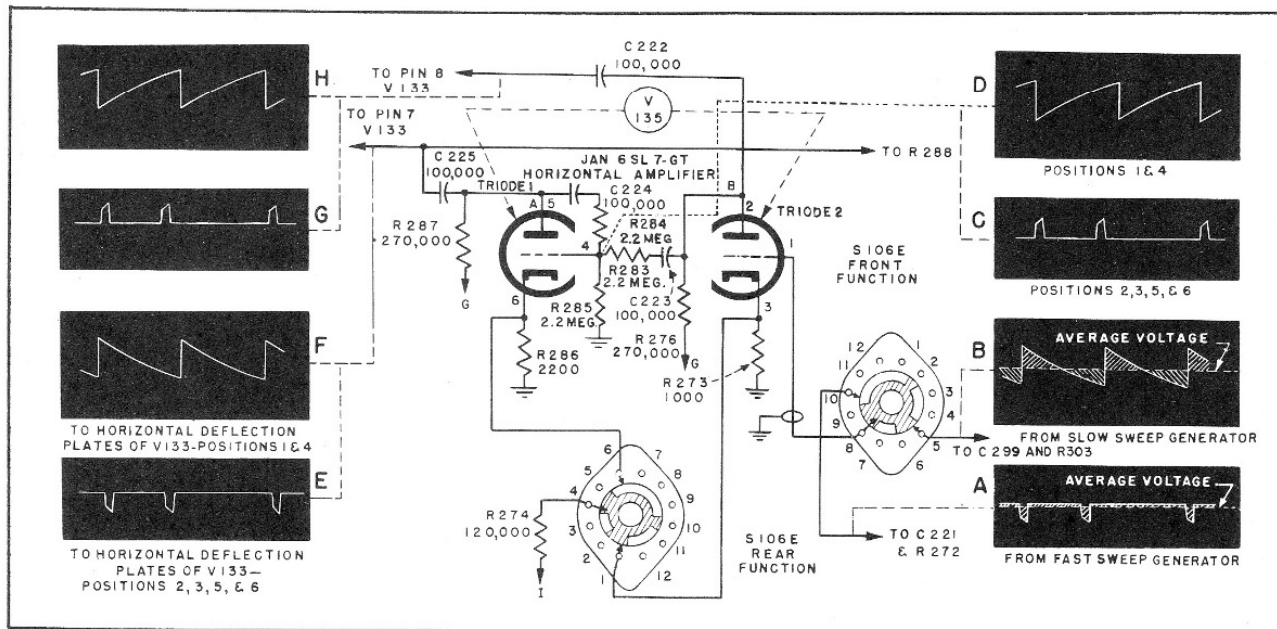


Figure 4-33. Horizontal Amplifier-Circuit—Schematic

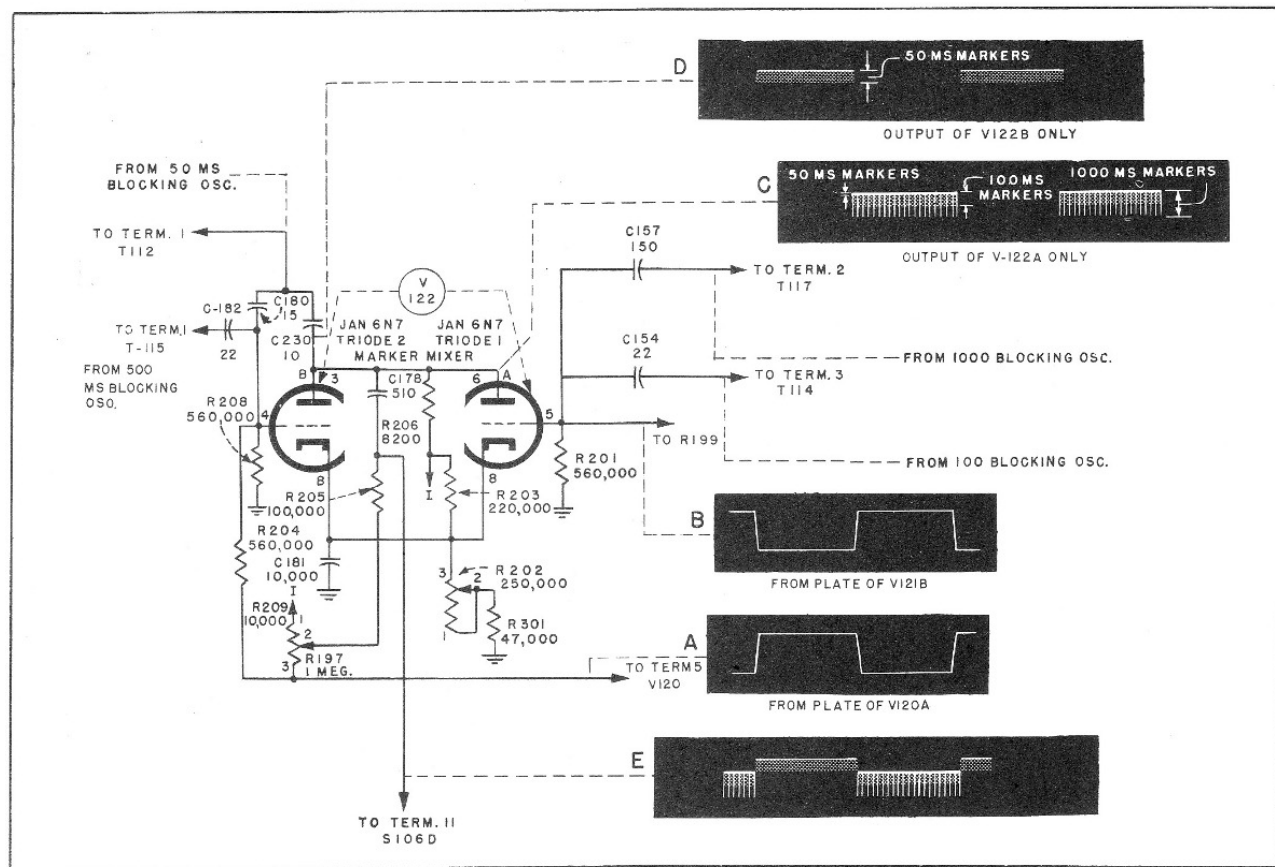


Figure 4-36. Marker Mixer Circuit—Schematic

The amplification produces a squaring action, since the slope which formerly applied to only a portion of the wave front is now increased to apply to the total amplitude. The wave form appearing at the plate of the triode (V-120-A) is shown at C in figure 4-35. This signal is fed to the grid of the amplitude balance triode (V-121-B) where it is again clipped, and part of the negative portion further squared by amplification as previously described. The output wave of the triode (V-121-B) is shown at D. Since a 180-degree phase reversal occurred with the second amplification, two similar square waves in opposite phase are available from the plate circuits of the two triodes (V-120-A and V-121-B). These are fed into the opposite ends of "AMPLITUDE BALANCE" control (resistor R-191) and the combined output as determined by the position of the arm is used to supply the r-f amplifier grid bias.

With the arm of the control electrically centered, the outputs of the triodes (V-120-A and V-121-B) are combined in equal amounts, and the level during each half cycle of the output wave is equal. (See E₁, fig. 4-35.) The sharp jogs in the wave at the start of each half cycle are due to the difference in the two wave shapes caused by the second clipping and squaring operation. These jogs do not affect operation, as no use is made of the voltage during the intervals in which they occur. With the arm of the control toward the plate of the

triode (V-120-A), its plate wave form predominates, producing an output wave in phase with this plate wave. (See E₂, figure 4-35.) With the arm toward the other triode V-121-B, (E₃, figure 4-35), the opposite wave predominates, and the opposite phase exists on the output wave.

The output from the arm of the "AMPLITUDE BALANCE" control is connected to the plate and grid of a triode (V-121-A) which is operated as a diode serving as a d-c restorer. Whenever the output attempts to go positive, the diode plate becomes positive with respect to ground and rectification occurs. Thus, the control voltage applied to the grid of the r.f. tube can only swing negative and positive with respect to ground.

In addition to supplying the amplitude control voltages, the plate voltage wave is also used in the marker mixer circuit to develop the pattern on the indicator screen in "FUNCTION" switch position 5. In positions 2 and 6, the output of the second squaring amplifier (V-121-B) is also used to provide the vertical deflection for trace separation.

(j) **MARKER MIXER.**—The marker mixer combines the timing pulses from the 50-, 100-, 500-, and 1000-microsecond blocking oscillators together with the square waves from the plates of the first and second squaring amplifiers of the amplitude balance circuits.

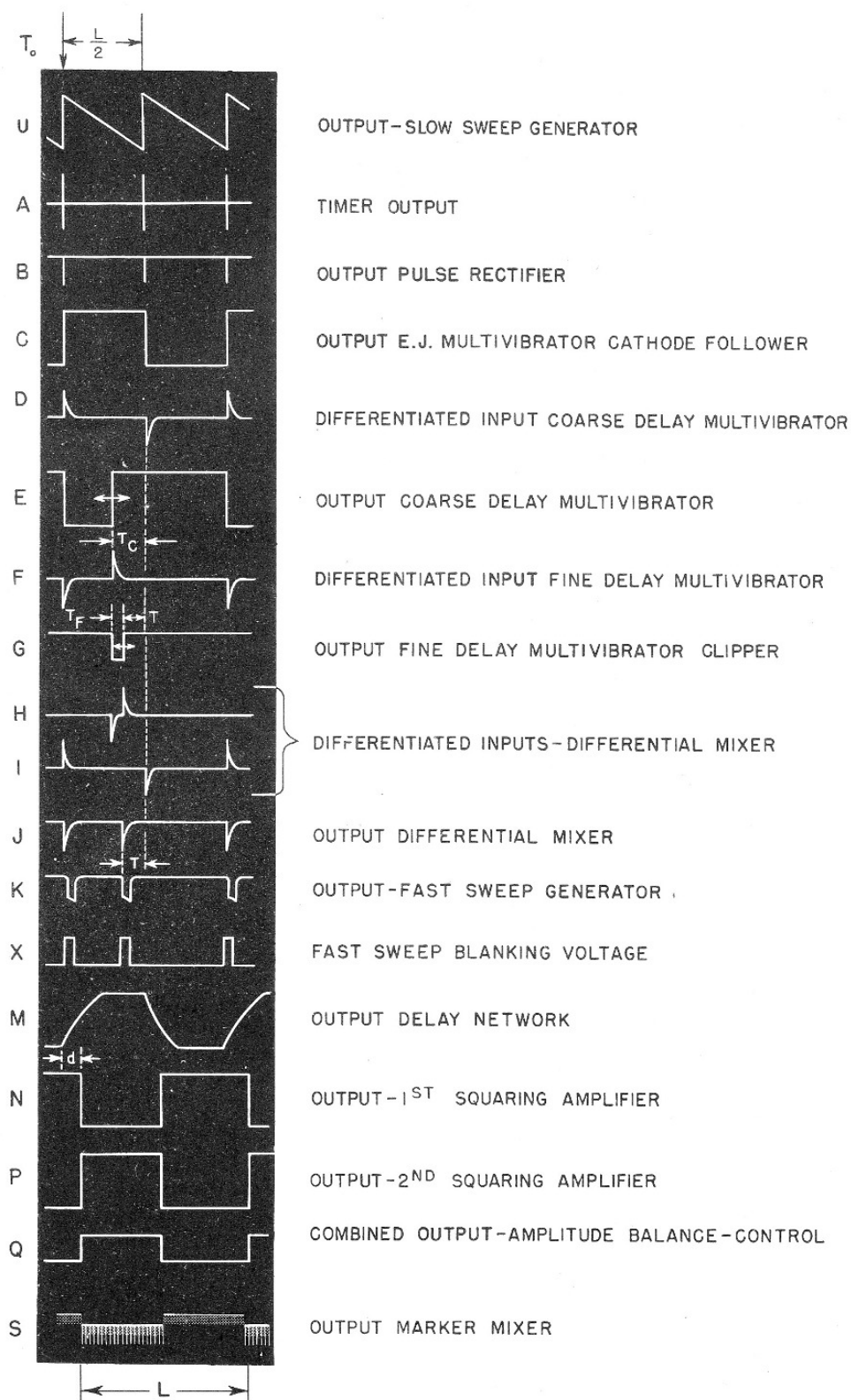
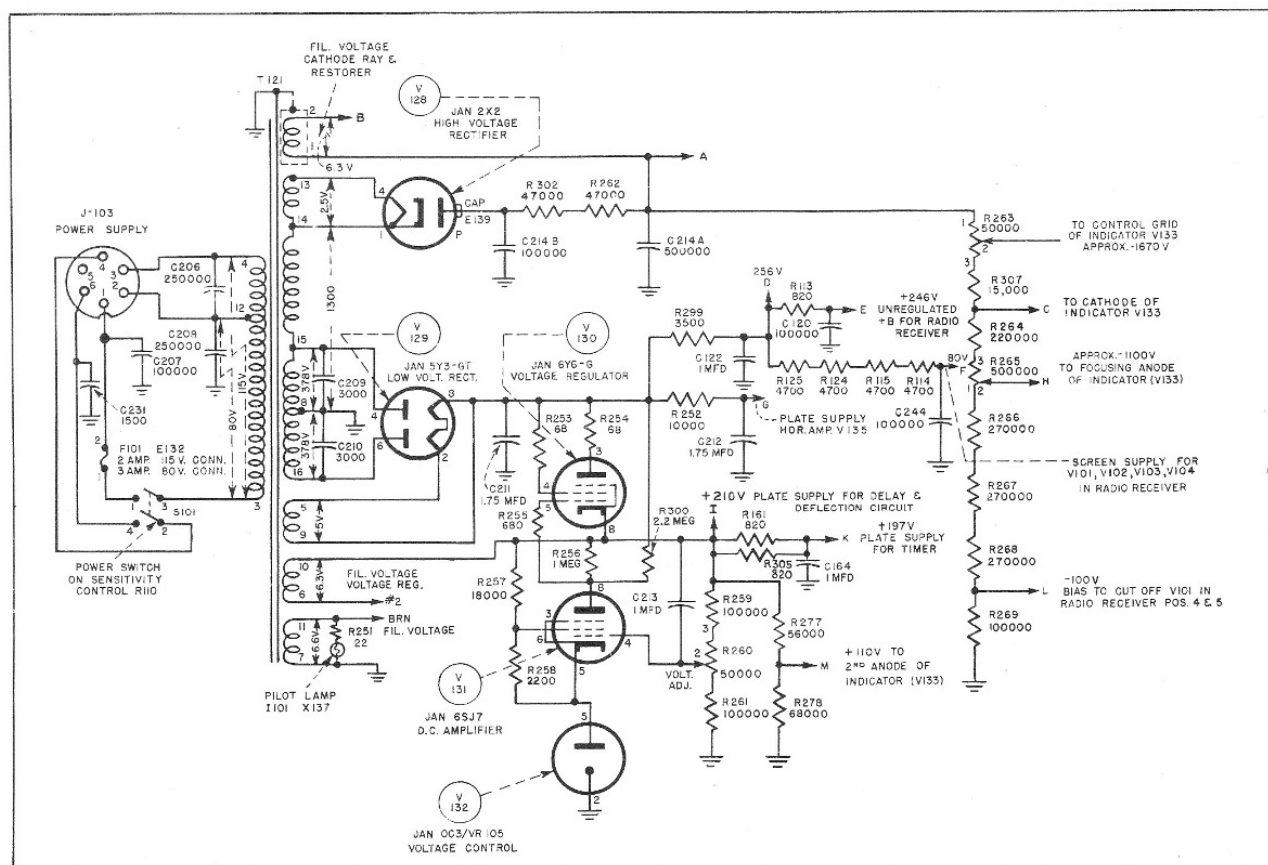


Figure 4-37. Time Relations in Delay and Deflection Circuits



Low voltage rectifier V-129 is fed from terminals 15 and 16 on the secondary winding, and operates as a

full wave rectifier. Since this rectifier can draw current only when its plates are positive with respect to its filaments, the rectified voltage is positive with respect to ground. Filter capacitor C-211 is used for all +B circuits while the resistor-capacitor networks (R-299 and C-122, R-113 and C-120, and R-252 and C-212) form the remainder of the filter circuits, and provide decoupling between the various circuits where unregulated +B voltage is employed. Four resistors (R-125, R-124, R-115, and R-114) are employed to drop the voltage for application to the screen grids of the amplifier tubes (V-101, V-102, V-103, and V-104) in the radio receiver circuits. Capacitor C-107 is the screen bypass for these tubes.

Three tubes (V-130, V-131, and V-132) form a voltage regulator system to provide constant voltages to the timer and deflection and delay circuits, unaffected by variations in either the applied line voltage or in the load on the rectified supply. The voltage regulator tube (V-130) is operated as a triode, with its plate and screen connected to the source of rectified voltage, and its cathode connected to the top of a bleeder string (R-259, R-260, and R-261), and to points I, K, and M, which feed regulated +B voltage to the various circuits of the equipment. Thus, this triode (V-130) is connected in series with the regulated +B output and must conduct the entire regulated +B current. The plate im-

pedance of this triode is a function of its grid to cathode bias, which controls the impedance presented to the flow of plate current in the tube. The triode may, therefore, be considered as a variable series resistance with its value dependent upon the applied grid to cathode bias. Resistors R-253, R-254, and R-255 in the screen, plate, and control grid circuits of the triode are incidental to its regulating operation, and are provided only to suppress parasitic high frequency oscillation.

The grid to cathode bias for the triode (V-130), which adjusts the magnitude of the series resistance presented, is obtained from the d-c amplifier (V-131) and reference voltage source V-132. The plate of the pentode amplifier (V-131) is connected to the control grid of the triode (V-130) its cathode to the constant potential plate of the gas discharge tube (V-132) and its control grid to the arm of potentiometer R-260 in the shunt bleeder string (R-259, R-260, and R-261). Screen grid voltage for the pentode (V-131) is obtained from the bleeder (R-257 and R-258). Tube V-132 is a gas discharge tube so designed that current flows only after the plate potential passes a certain critical value. When this value is exceeded the tube fires and reduces the plate voltage to a second critical value where the voltage becomes stabilized as long as the current remains above a certain minimum value. In gas tube V-132 which is a JAN-OC3/VR105 type, this operating voltage is fixed by the design of the tube at 105 volts. The plate voltage thus becomes stabilized at this fixed point and can neither be increased nor decreased. Thus, a constant reference voltage is established for the plate of the control tube and hence for the cathode of the pentode (V-131). The current drawn by this pentode is controlled by its control grid to cathode bias, which may be adjusted by setting potentiometer R-260. This current results in a voltage drop across resistor R-256 in the plate circuit and this drop impressed between grid and cathode of the regulator tube (V-130), controls its series resistance, and hence the value of the regulated +B voltage.

Voltage regulation or correction occurs as outlined in the following explanation. Should the voltage at I, the top of the bleeder, change, a portion of the change is applied to the grid of the pentode V-131 from the tap of potentiometer R-260. Since the cathode potential of the pentode is held constant by the gas tube V-132, a change in bias on the pentode results in a change in its current and hence the drop across resistor R-256 will also change. The change in voltage drop across resistor R-256 changes the bias on the triode V-130, thus changing its impedance in such a direction as to return the voltage at I to its original level.

For example, as the voltage at I attempts to decrease the grid potential tries to decrease, and hence the bias on the pentode (V-131) tries to increase. This results in a decreased current through the pentode, and consequently a decreased drop across resistor R-256. The decreased drop across resistor R-256 drives the grid of the triode (V-130) less negative with respect to its cathode, increasing the ability of the tube to draw

current, hence decreasing its series resistance, thereby increasing the voltage at I to its original value. Resistor R-300 connected from the rectified source to the grid of the triode (V-130), through resistor R-255, places a residual positive voltage between the grid and cathode of the triode. With this arrangement, zero voltage drop across resistor R-256 is obtained with a current in V-131. In consequence, it is possible to control the bias on V-130 effectively over the entire range between 0 volts and the cutoff value. Capacitor C-213 passes the rapid voltage changes (including any superimposed a-c components of the regulated +B output) directly to the grid of the pentode V-131 and thus permits the regulator circuit to respond to these rapid changes. Resistor R-161 and capacitor C-164 provide filtering and decoupling of the supply for the timer from the other circuits which are supplied from regulated +B.

An important function of the regulated voltage supply other than maintaining a constant voltage source, is its filtering action. In the same manner, as the system compensates for variation of the d-c level of the output voltage, it also compensates for any a-c signals superimposed on the output, and adjusts its regulation to smooth them out. Thus, any signals from the various circuits which would normally appear on the +B line are eliminated by the regulator, and thus prevented from coupling into other circuits.

Capacitors C-209 and C-210 in the secondary winding of transformer T-121 which feeds the low voltage rectifier and three capacitors (C-206, C-207, and C-208) in the primary winding of T-121 serve to prevent the high frequency components produced by the rectifier from appearing on the power line. The values of capacitors C-206, C-207, and C-208 are such as to balance the impedance of each line lead with respect to ground and to produce maximum filtering. Capacitor C-231 serves to prevent extraneous signals picked up in the wiring and other components from appearing on the terminals 4 and 6 of power plug J-103.

e. INDICATOR TUBE CIRCUITS.—The cathode ray indicator tube provides the means for visually displaying the patterns required for setting up and reading the indicated time difference.

Figure 4-39 shows the indicator tube and its associated centering circuits. The tube itself (V-133) consists of a cathode (pin 2) which emits the required electron stream; an anode (pin 9) which attracts the electron stream in the direction of the screen; a focusing anode (pin 5) which focuses the stream into a concentrated beam; a control grid (pin 3) which controls the flow of the stream; the horizontal and vertical deflection plates, (pins 7 and 8, and 10 and 11, respectively), which direct the beam; and a fluorescent screen on the viewing end of the tube, which responds to the beam by phosphorizing at the spot where the beam strikes.

The cathode is operated at -1650 volts with respect to ground, and the anode at +110 volts, thus placing the anode at +1760 volts with respect to the cathode, and causing electrons from the cathode to move rapidly in its

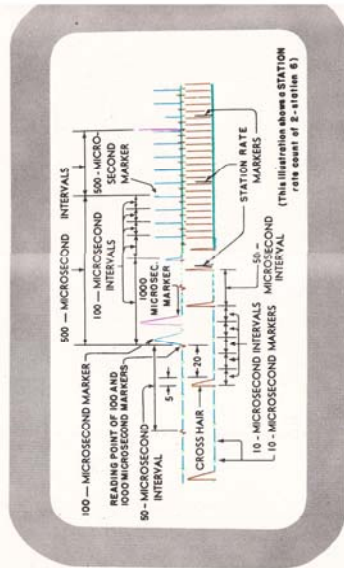
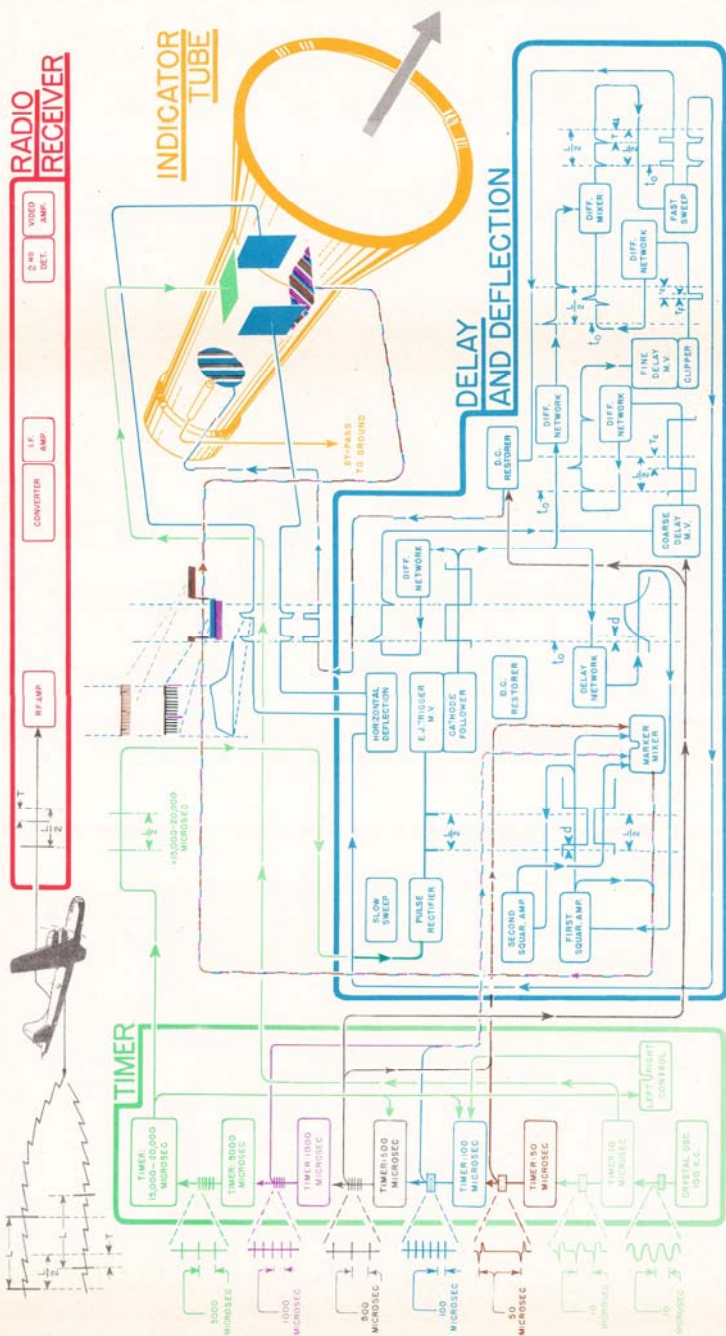
RADIO RECEIVER

NOTE 1:-

THE INDICATOR SCREEN TRACERS AND TRACE MARKERS ARE COLORED TO CORRESPOND WITH THE COLORS ON THE DEFLECTION PLATES TO WHICH THEY ARE RELATED.

NOTE 2:-

THE COLORS OF THE FUNCTIONAL BLOCKS SHOWN IN THIS AND PRECEDING BLOCK DIAGRAMS CORRESPOND TO THE COLORS SHOWN ON THEIR RESPECTIVE UNIT ILLUSTRATION FIG. 6-21, 6-22, 6-23, AND 6-24.

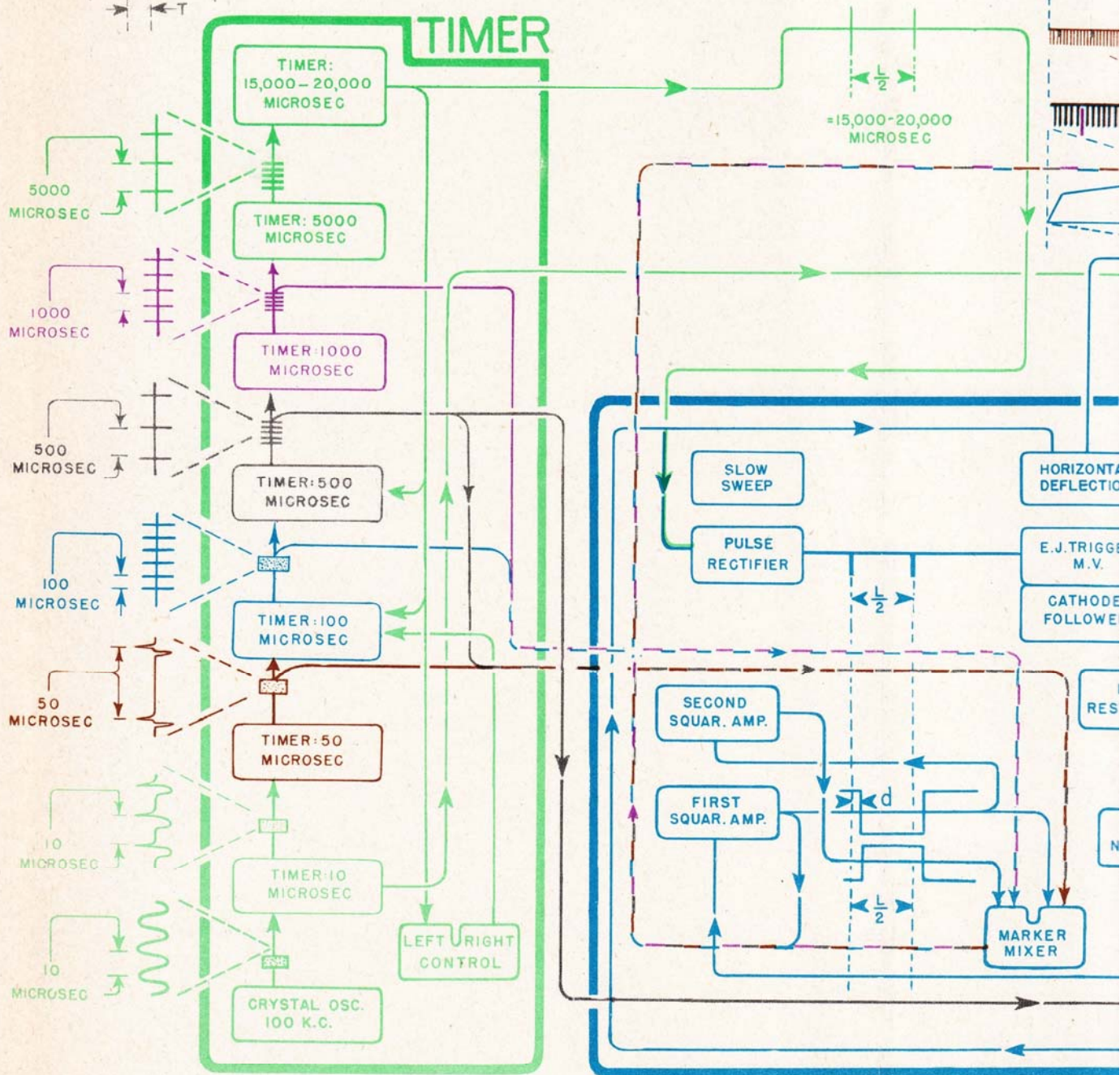


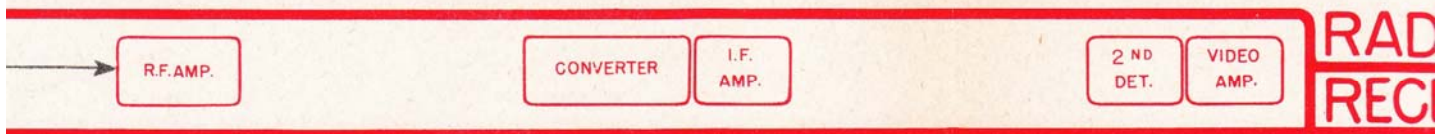
INDICATOR SCREEN POSITION 5

Figure 4-45. Function Switch Position 5—Block Diagram

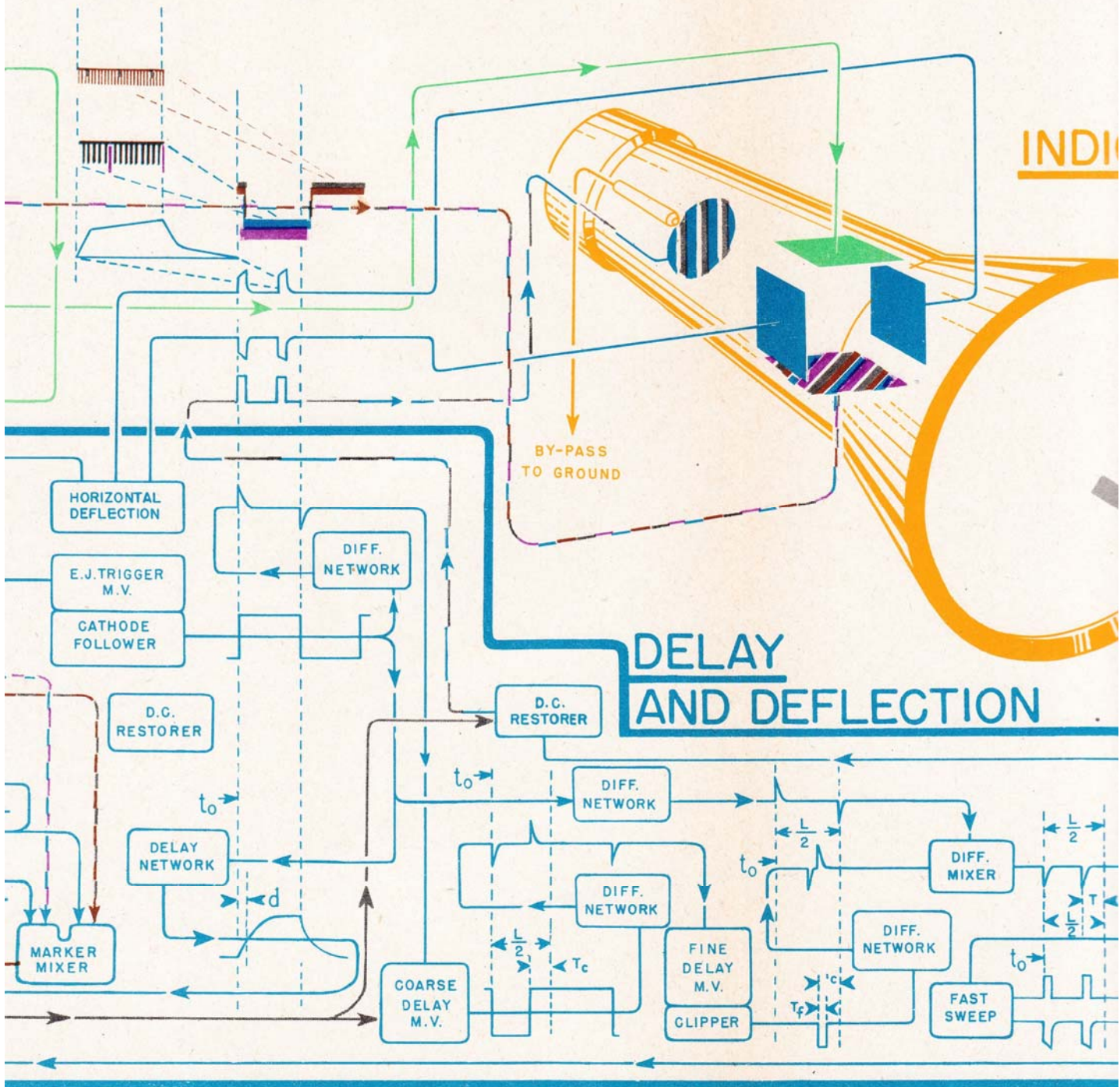
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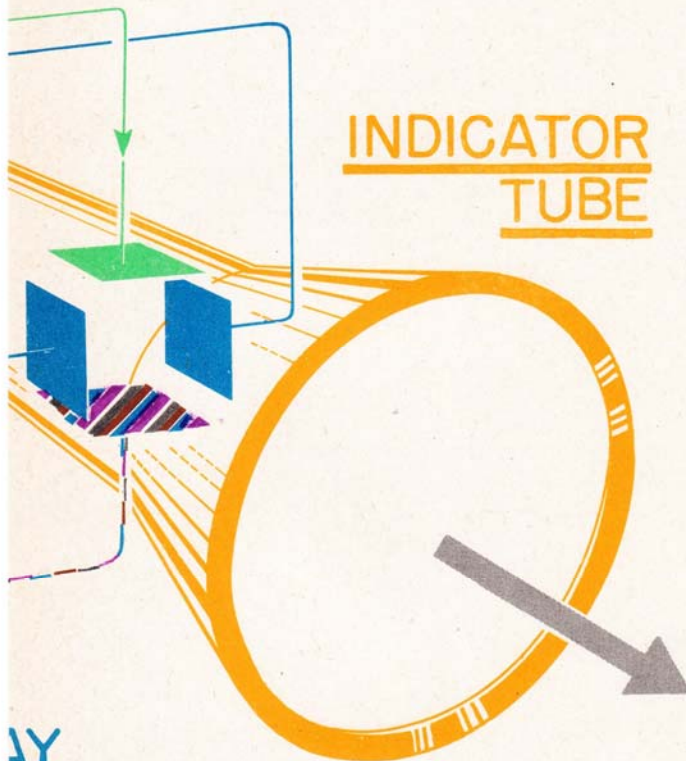
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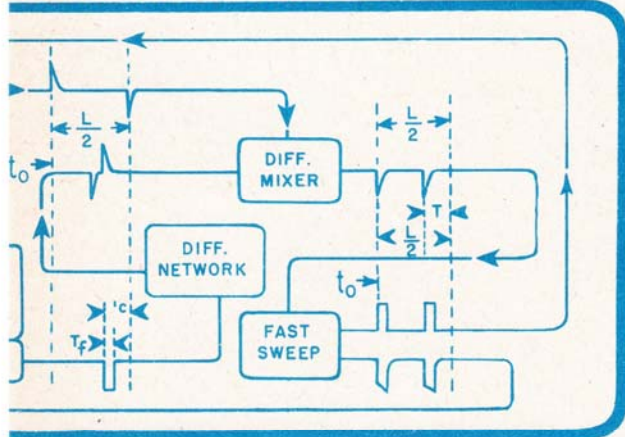
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RADIO RECEIVER



INDICATOR
TUBE

RAY
DEFLECTION



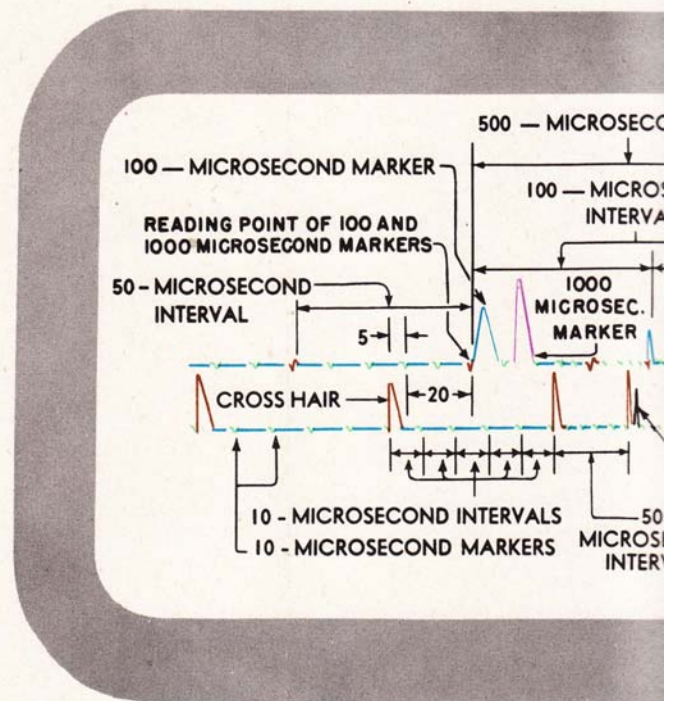
NOTE 1:-

THE INDICATOR SCREEN TRACES ARE COLORED TO CORRESPOND DEFLECTION PLATES TO WHICH

NOTE 2:-

THE COLORS OF THE FUNCTIONAL AND PRECEDING BLOCK DIAGRAM COLORS SHOWN ON THEIR RES

FIG. 6-2I, 6-2



INDICATOR S
POSITION

Figure 4-45. Function Switch Po

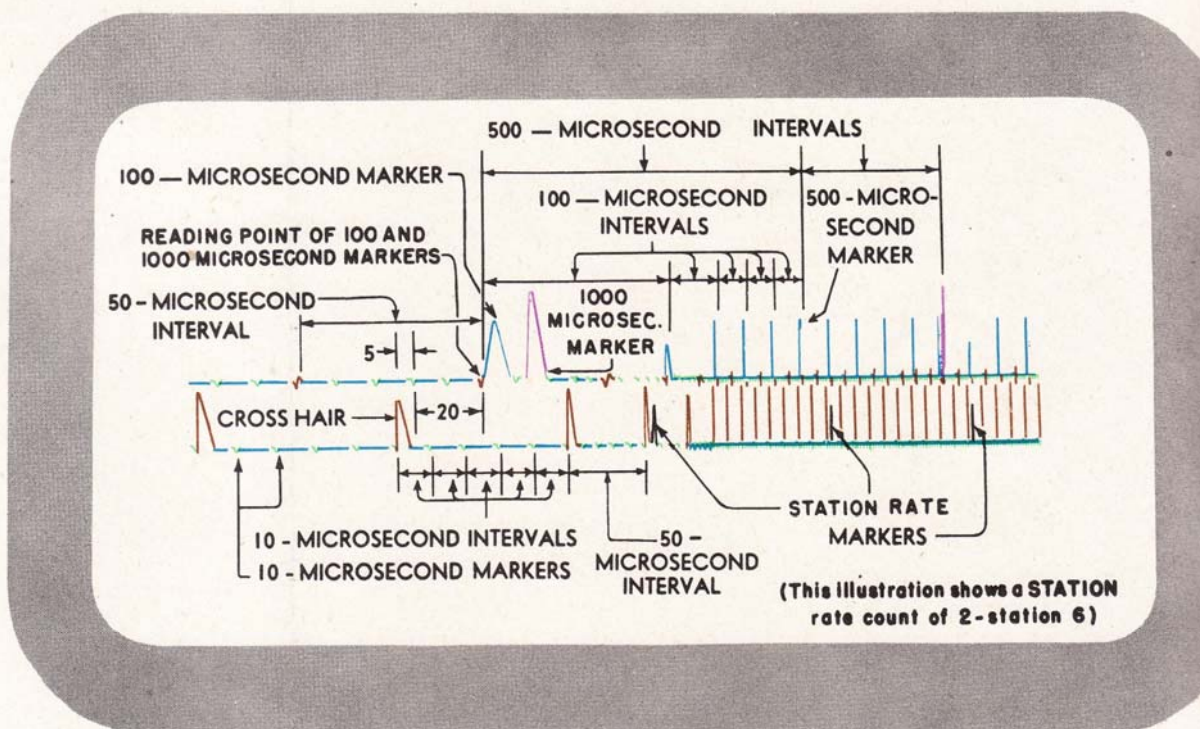
NOTE 1:-

THE INDICATOR SCREEN TRACERS AND TRACE MARKERS ARE COLORED TO CORRESPOND WITH THE COLORS ON THE DEFLECTION PLATES TO WHICH THEY ARE RELATED.

NOTE 2:-

THE COLORS OF THE FUNCTIONAL BLOCKS SHOWN IN THIS AND PRECEDING BLOCK DIAGRAMS CORRESPOND TO THE COLORS SHOWN ON THEIR RESPECTIVE UNIT ILLUSTRATION

FIG. 6-21, 6-22, 6-23, AND 6-24.



INDICATOR SCREEN POSITION 5

Figure 4-45. Function Switch Position 5—Block Diagram

SECTION V MAINTENANCE

WARNING

This equipment employs high voltages which are dangerous to life. Maintenance and operating personnel should use extreme care when working with Receiver-Indicator R-65/APN-9. Such circuit elements as the "BRILLIANCE" control, "FOCUS" control, brilliance restorer, power transformer, high voltage rectifier, and filter operate on high voltage. The operator should turn the power supply off, remove the power connector plug, and discharge all capacitors in the circuits mentioned above prior to touching them.

1. EQUIPMENT REQUIRED FOR MAINTENANCE.

<i>Unit</i>	<i>Army Type Designation</i>	<i>Navy Type Designation</i>
Oscilloscope	RCA-158 Reiner 550 A, Dumont 208 B, or equal	Dumont 241 or TS-34/AP
Signal Generator*	I-72 or Ferris 22A	Navy Model LM (), LP (), or Hickok 19X
Output Meter	Weston Model 571 Type 3A Triplet Model 650-SC Espey Model 103	Weston Model 687 or Simpson Model 427
Vacuum Tube Voltmeter	RCA Voltomyst, Jr. 165	Radio City Products Model 662
Volt-ohm- milliammeter	Any of the set analyz- ers which are parts of Test Sets I-56-A through I-56-K may be used; for example, Weston set analyzer, Model 655, Type 2	Navy Model OE or Hickok Model 133 or Simpson Model 260 or Triplet Model 1200

<i>Unit</i>	<i>Army Type Designation</i>	<i>Navy Type Designation</i>
Frequency Meter Set	SCR-211 ()	Navy Model LM-13
Test Set	TS-251/UP	

*The signal generator will be replaced by a signal generator based on Ferris 22A design and will be part of AN/ARM-3.

Note

Radio Set RC-242, Loran training equipment which consists of Signal Generator I-194-A and Indicator ID-6/APN-4, is used by aviation maintenance activities of the Navy as well as by training activities. As maintenance equipment, Radio Set RC-242 is used to simulate a Loran transmitting station to facilitate performance checks on Radar Set AN/APN-9.

2. LOCATION OF CONTROLS AND ADJUSTMENTS.

Figures 5-1, 5-2, 5-3, and 5-4 show the locations of the controls and adjustments referred to in this section.

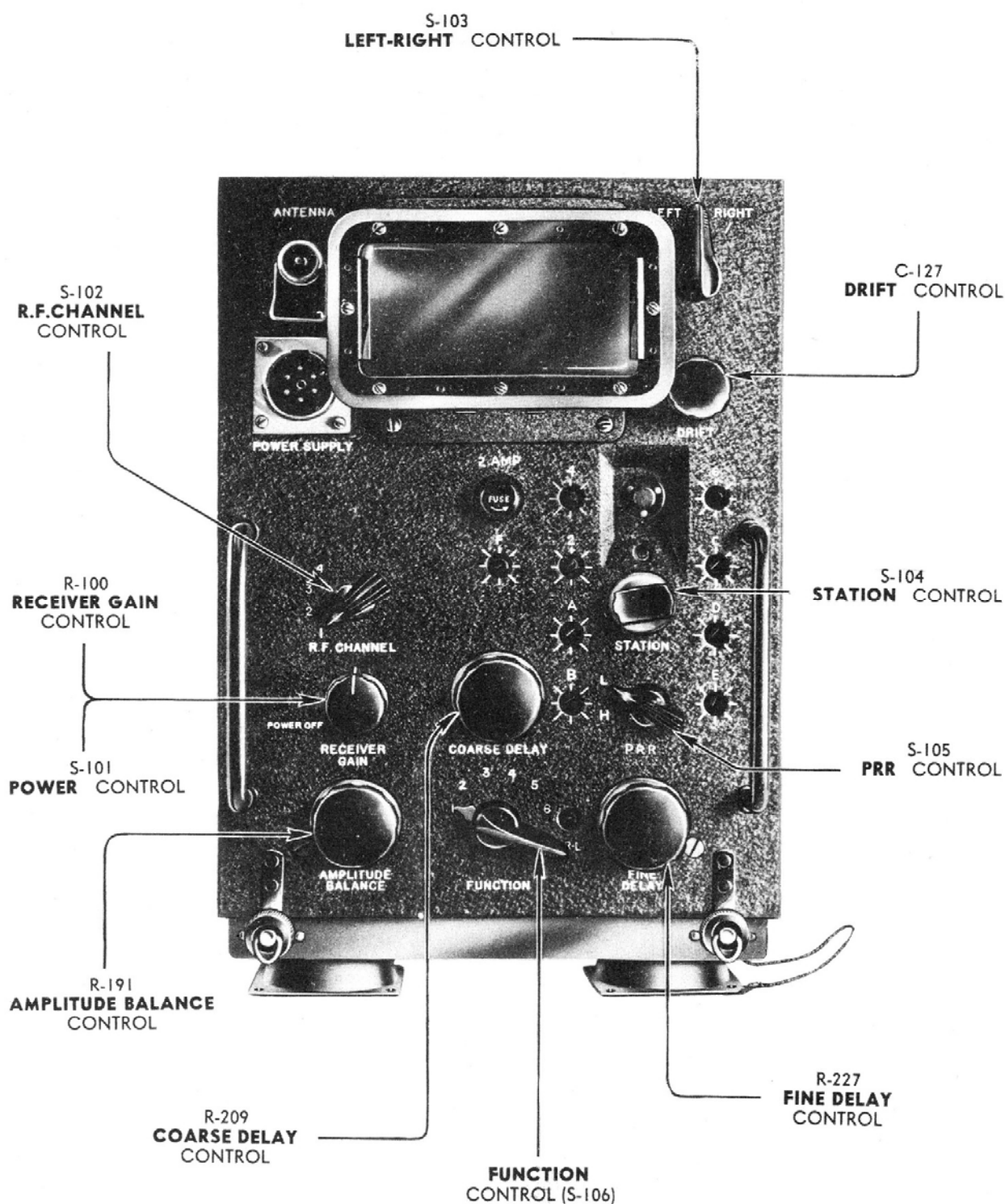


Figure 5-1. Receiver-Indicator R-65/APN-9—Operational Controls

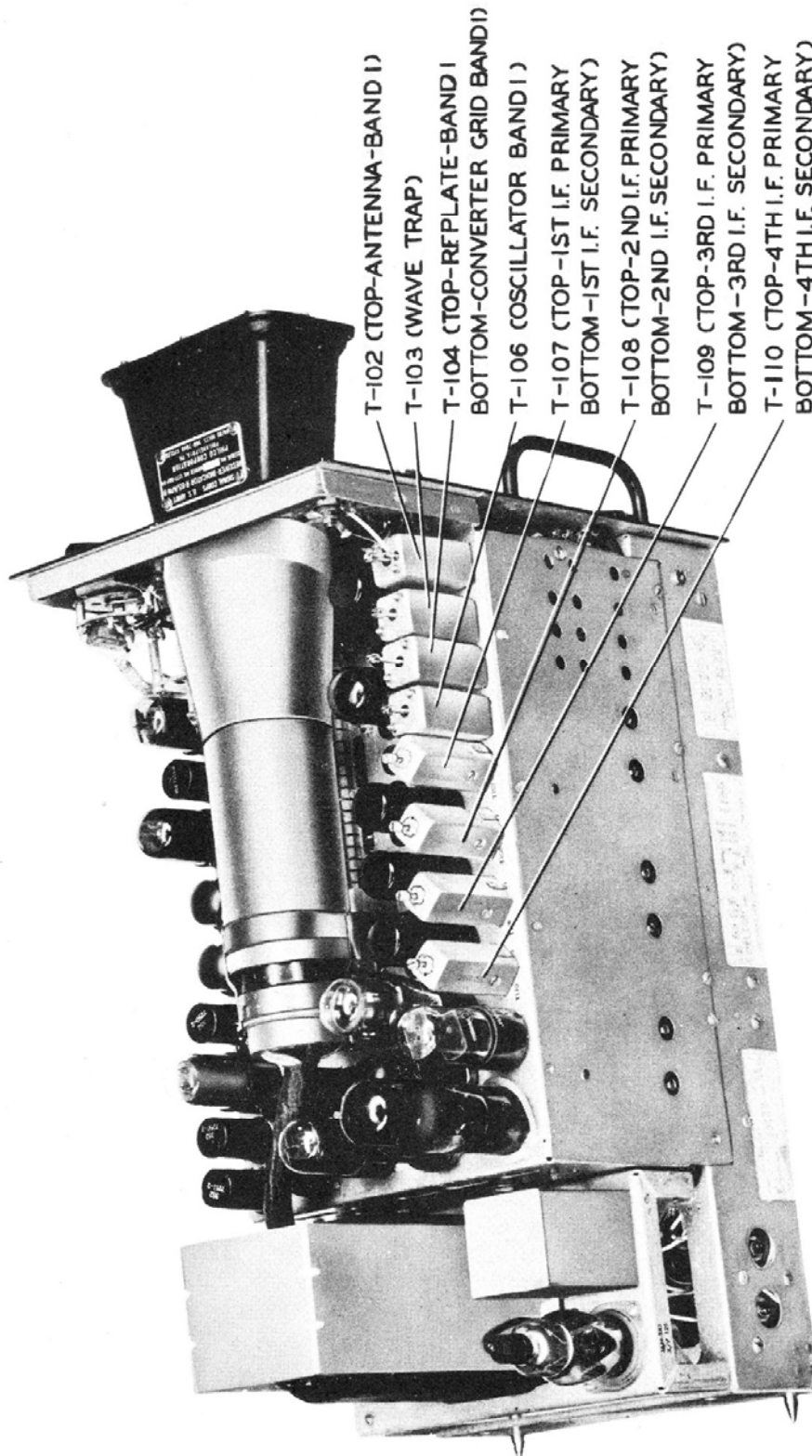


Figure 5-4A. Receiver-Indicator R-65/APN-9—Modified, Left Top View

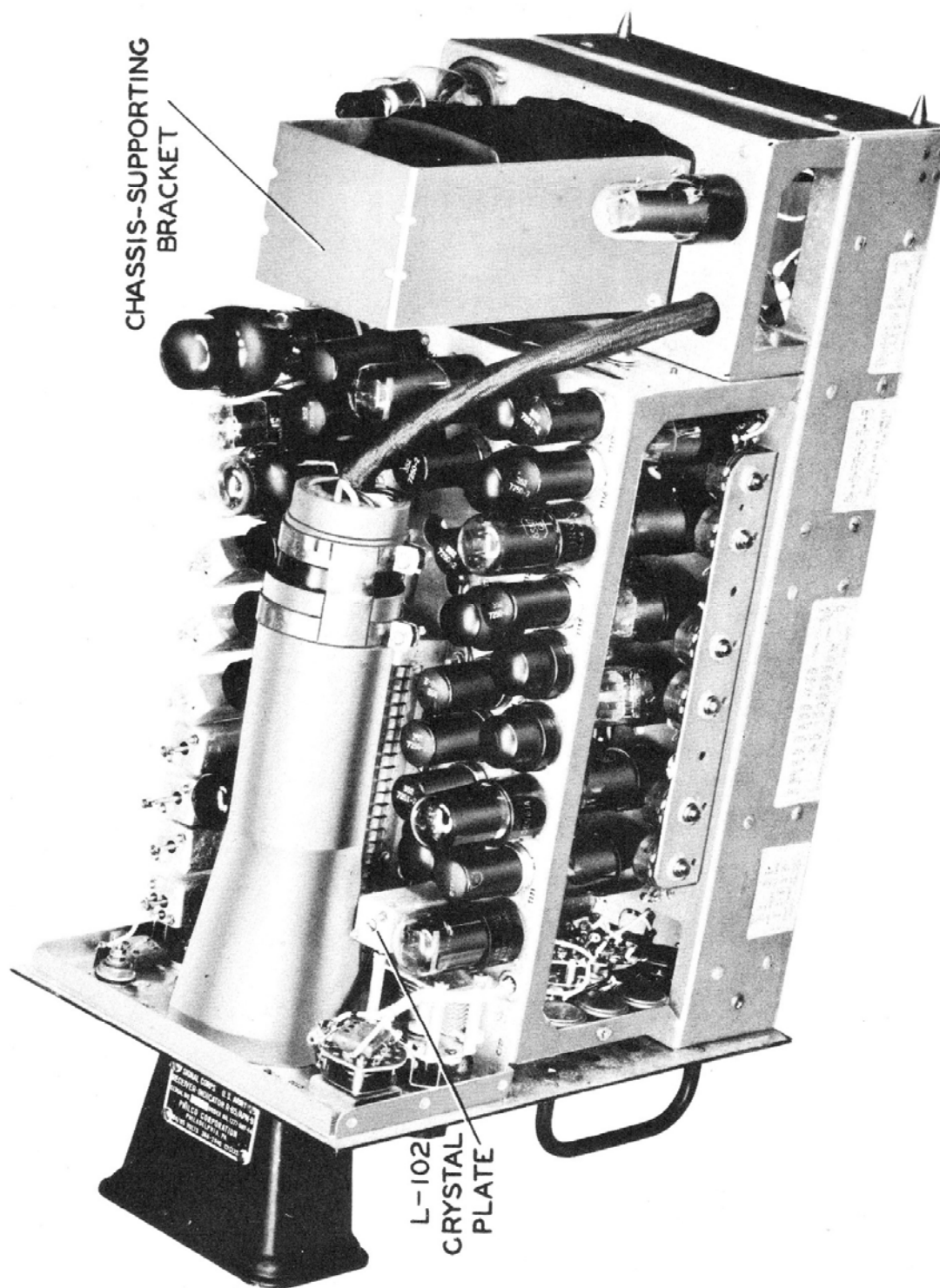


Figure 5-4B. Receiver-Indicator R-65/APN-9—Modified, Right Top View

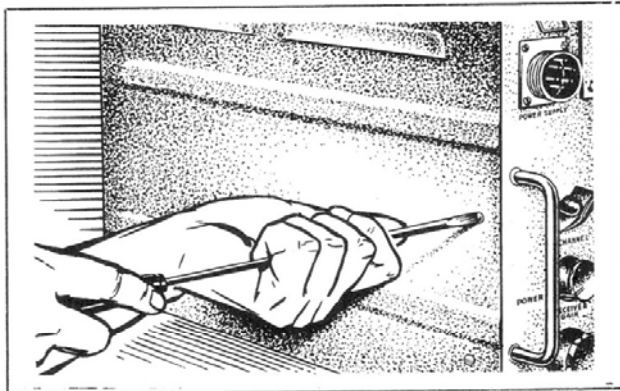


Figure 5-5

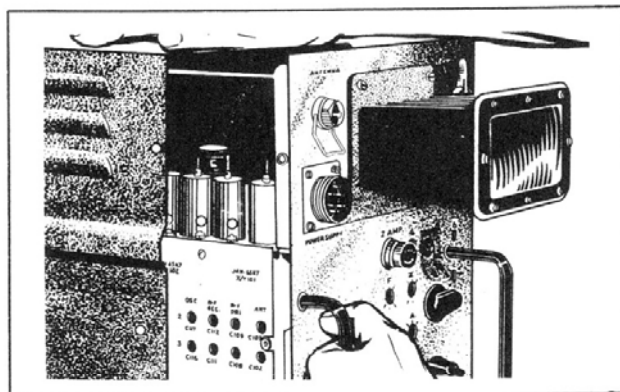


Figure 5-6

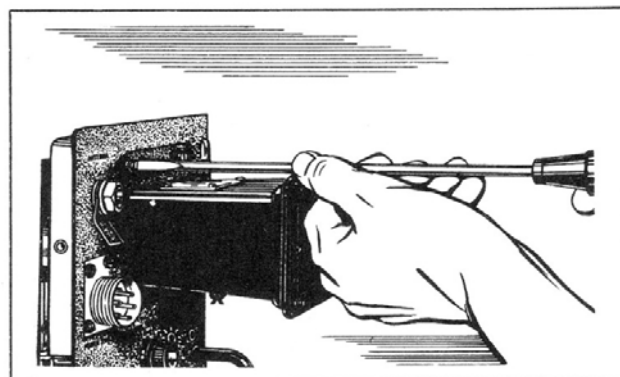


Figure 5-7

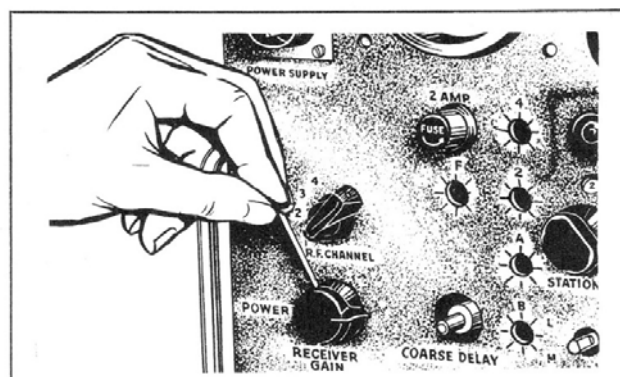


Figure 5-8

3. DISASSEMBLY, REPLACEMENTS, AND ADJUSTMENTS (MECHANICAL).

a. DISASSEMBLY.

(1) REMOVAL OF DUST COVER.

Step 1. Remove the nine screws located on the dust cover behind the front panel.

Step 2. Slide the receiver-indicator out of the dust cover.

(2) REMOVAL OF FRONT PANEL.

Step 1. Remove the lens holder by extracting the four screws located at each corner of the mounting plate.

Step 2. Remove all the control knobs from the front panel with an Allen wrench.

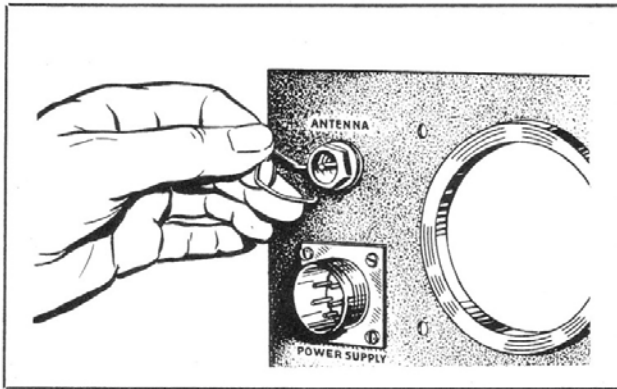


Figure 5-9

Step 3. Remove the clamping wire of the "ANTENNA" connector (J-102).

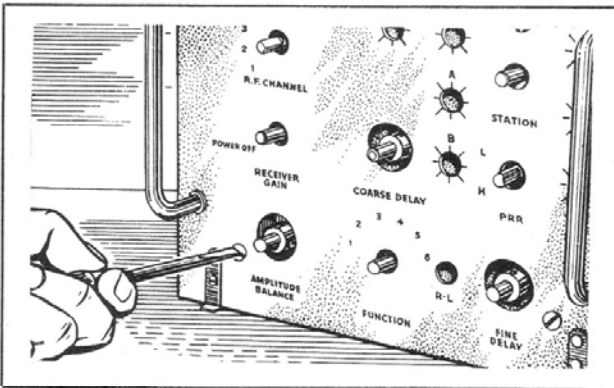


Figure 5-10

Step 4. To remove the front panel, extract the two screws from the lower part of this panel.

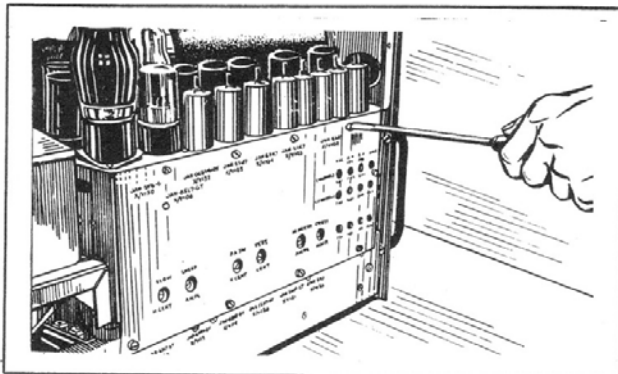


Figure 5-11

(3) REMOVAL OF THE RECEIVER TIMER CHASSIS FROM THE DEFLECTION CHASSIS.

Step 1. Remove the shield plate on the left hand side of the receiver-indicator by extracting the eight screws.

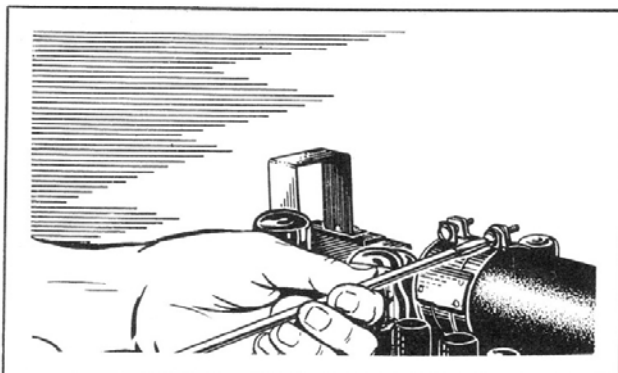


Figure 5-12

Step 2. Detach the indicator tube clamp from the indicator shield by loosening the shield clamp screw as shown in figure 5-12. Remove indicator tube. (See paragraph 3b(1), this section.)

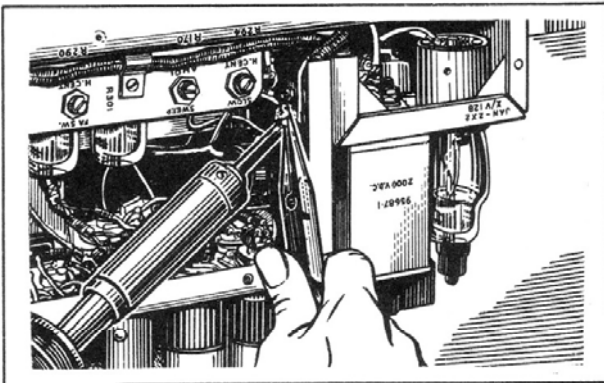


Figure 5-13

Step 3. Turn the receiver-indicator upside down, and rest it on the bracket mounted on the power supply transformer.

Step 4. Unsolder the four inter-unit leads on terminal board E-113 (inside of rear apron on the timer chassis).

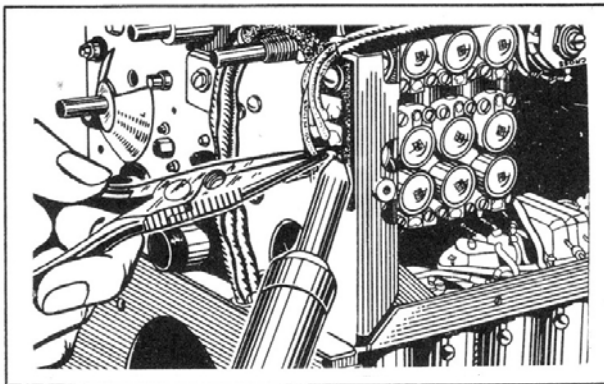


Figure 5-14

Step 5. Unsolder the three inter-unit leads on the terminal board E-112 (outside of the front apron on the timer chassis).

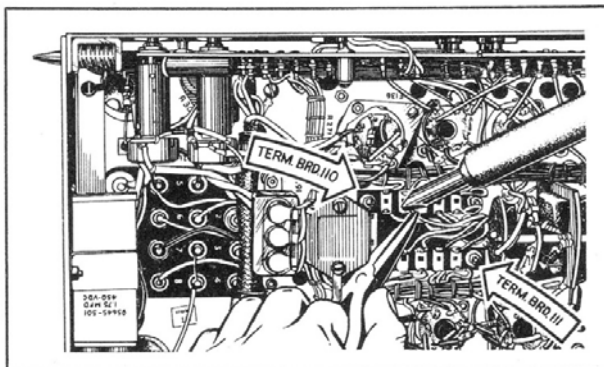


Figure 5-15

Step 6. Unsolder the five inter-unit leads on terminal board E-110 and the five inter-unit leads on terminal board E-111 (bottom of the deflection chassis).

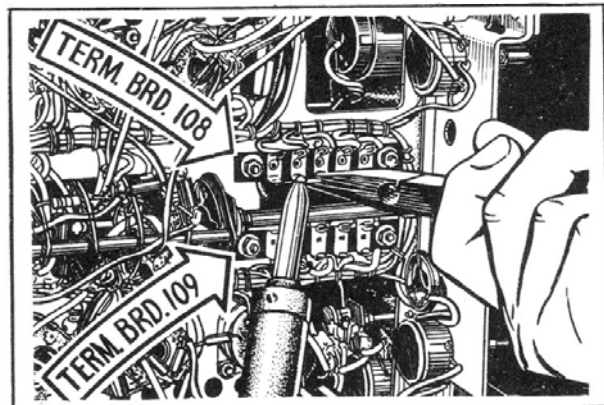


Figure 5-16

Step 7. Unsolder the five inter-unit leads on terminal board E-108 and the five inter-unit leads on terminal board E-109 (bottom of the deflection chassis).

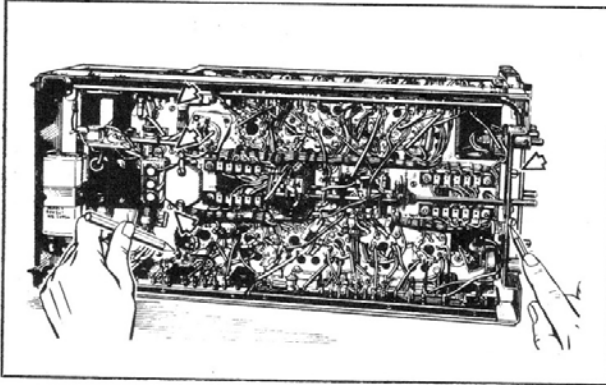


Figure 5-17

Step 8. Extract the six screws, accessible from the underside of the deflection chassis (see figure 5-17). Carefully turn the receiver-indicator top side up.

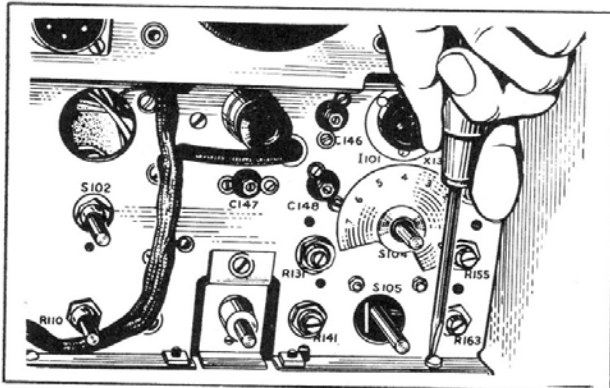


Figure 5-18

Step 9. Extract the three screws from the front of the deflection chassis.

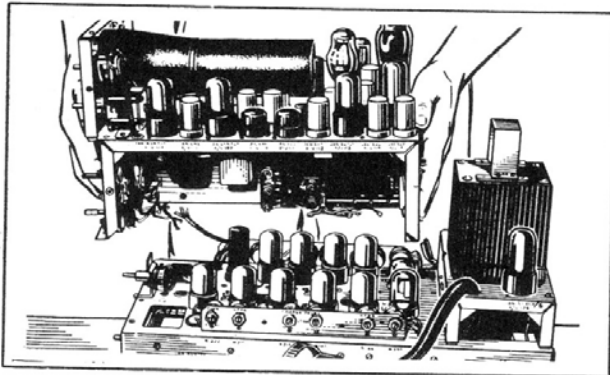


Figure 5-19

Step 10. Separate the receiver timer from the deflection chassis.

b. REPLACEMENTS.

(1) REPLACEMENT OF INDICATOR TUBE.—The 3BP1 tube supplied with Receiver-Indicator R-65/APN-9 should be the latest design, with pins No. 2 and No. 4 internally connected. For best operation, use only tubes with this connection. Check for this connection with a continuity meter, whenever the 3BP1 is replaced, or if doubt exists as to the origin of the tube in the equipment.

Step 1. Remove the dust cover, and lens holder as described above in paragraph 3a(1), Steps 1 and 2, and paragraph 3a(2), Step 1, this section.

Step 2. Remove the rubber cushion from the front end of the indicator tube.

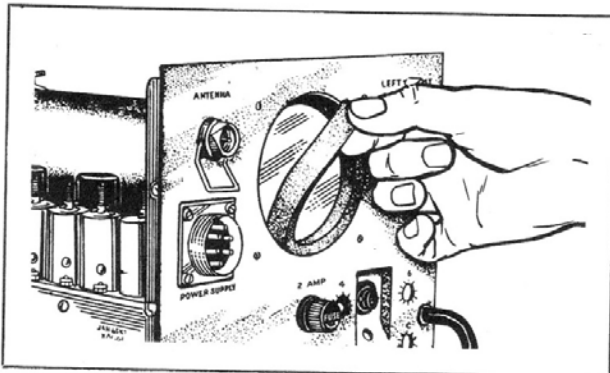


Figure 5-20

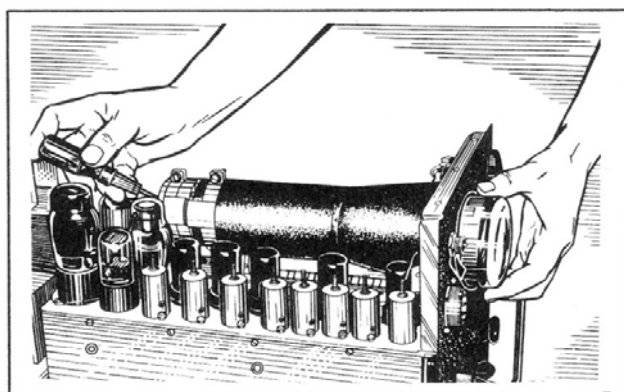


Figure 5-21

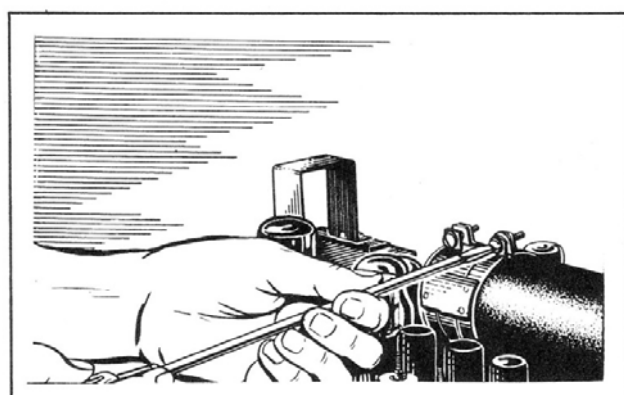


Figure 5-22

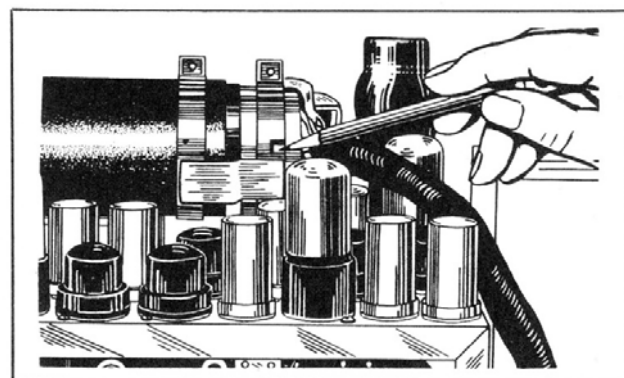


Figure 5-23

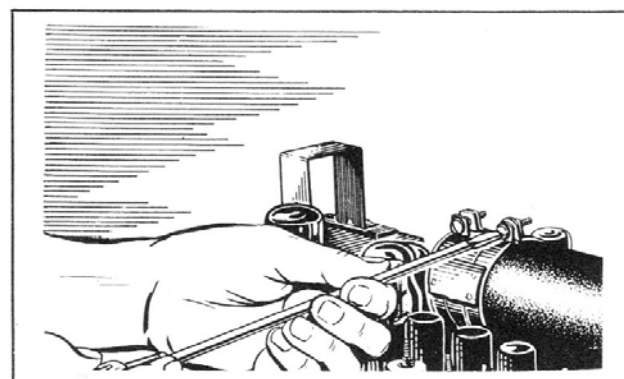


Figure 5-24

Step 3. Insert a screw driver through the opening in the indicator tube socket until the end of the screw driver comes in contact with the base of the indicator tube. Grasp the front or screen end of the tube with one hand, and with the screw driver in the other hand, apply sufficient pressure to free the tube from the tube socket. The tube may now be extracted.

Step 4. Insert the new tube in the shield until the pins of the tube are firmly engaged with the socket. The screen end of the tube must be flush with the face of the front panel.

Step 5. If the screen end of the tube extends beyond or recedes from the face of the front panel, loosen the shield clamp (see figure 5-22).

Step 6. Slide the clamp (including the tube socket assembly) to the front or to the rear as required until the screen end of the tube is flush with the front panel, and tighten the clamp.

Step 7. Connect the power supply cable to the receiver-indicator receptacle and turn the power "ON" by rotating the "RECEIVER GAIN" knob clockwise; observe the trace indication on the indicator screen. If the trace is not *horizontal*, the shield clamp must be loosened and the indicator tube (including the tube socket assembly) must be rotated until the trace on the indicator screen is horizontal. If required readjust the "CENTERING," "TRACE LENGTHS," "FOCUS," and "BRILLIANCE" adjustments for the correct appearance of the trace.

Step 8. Replace the rubber cushion and reinstall the lens holder and the dust cover.

(2) **REPLACEMENT OF INDICATOR TUBE CLAMP**—Indicator tube clamp is located at the junction of the indicator tube socket and the indicator tube. Remove the indicator tube as described in paragraph 3b(1), this section, then detach it from the tube shield and the tube socket. Slip the new clamp on the indicator tube shield. Slide the *socket* band of the clamp on the socket, and align the center of the band with the shoulder on the socket. The detents of the band (see figure 5-23) must fit firmly against the shoulder on the socket. Tighten the socket band clamping screw securely at this position.

Replace the indicator tube and see that the pins are firmly engaged with the socket receptacle. Make sure that the screen end of the tube is flush with the face of the front panel. If the screen end of the tube extends beyond or recedes from the face of the front panel, move the tube socket assembly to the front or to the rear as required until the screen end of the tube is flush with the front panel. Tighten the clamping screw on the indicator tube shield. Turn on the equipment and if necessary orient the indicator tube as described in paragraph 3b, (1), Step 7, this section.

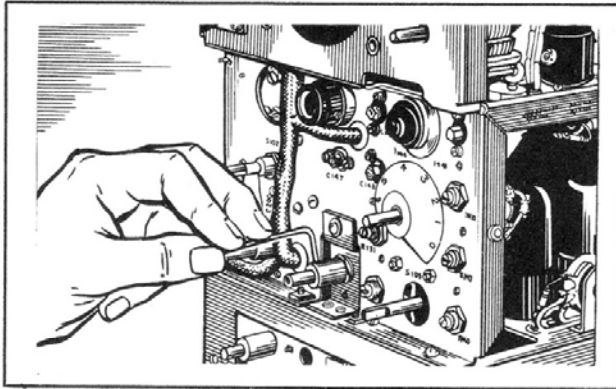


Figure 5-25

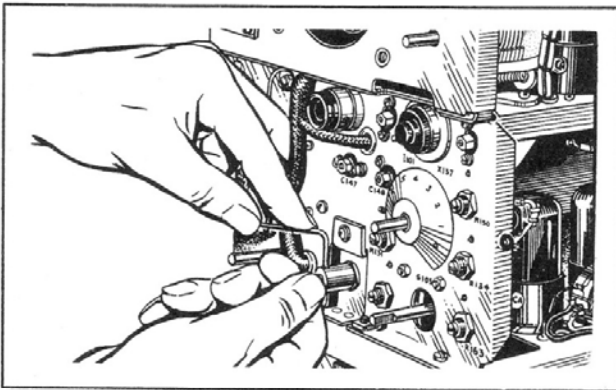


Figure 5-26

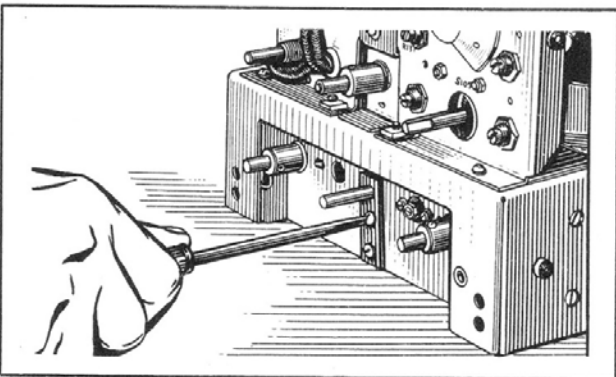


Figure 5-27

4. INSPECTION.

IMPORTANT

Periodic inspections prescribed herein represent minimum requirements. If, because of local conditions, peculiarities of equipment, or abnormal usage, these inspections are found inadequate to assure satisfactory operation of equipment, local authorities should not hesitate to increase their scope or frequency.

a. GENERAL.—Installation adjustments required for Receiver-Indicator R-65/APN-9 are given in section II, paragraphs 2b and 2c. Routine preventive maintenance inspections and tests to assure continuity of service appear

c. ADJUSTMENTS.

(1) RESETTING FRICTION COLLAR ON "FINE DELAY," "COARSE DELAY," AND "AMPLITUDE BALANCE" CONTROLS.

Step 1. Using the Allen set screw wrench, loosen the set screws in the friction collar, until the collar slides on the control shaft.

Step 2. Pull the control shaft, and at the same time, push the friction collar and spring washer against the control bearing. Tighten the Allen set screws in the friction collar. The adjustment should be such that a definite friction is obtained.

(2) RESETTING "FUNCTION" SWITCH BEARING.

Step 1. The "FUNCTION" switch bearing, which is located at the "FUNCTION" switch control shaft, is reset by loosening the two screws in the bearing plate after the switch has been mounted. The bearing should be allowed to center itself after which the two screws are tightened.

in this section as preflight, daily, and 100-hour inspections.

b. EXPLANATION OF NOTATION SYSTEM.—Periodic inspections of the airplane are divided into preflight, daily, and 100-hour-and-subsequent inspections. All inspection steps are not necessarily performed during the course of every inspection. Some steps are performed in only one inspection, some in two, but many are required in all three. The abbreviations used to indicate inspection periods are: P.F. for preflight, D. for daily, and 100 for the 100-hour-and-subsequent inspections.

(1) The preflight inspection is performed before every flight.

(2) The daily inspection is a check of the general condition of the complete equipment. This inspection is performed each calendar day.

(3) The Army 100-hour inspection (Navy 120-hour) includes removal of the units from their cases and a thorough and searching visual and operating inspection to determine maintenance work requirements and to de-

tect maladjustment and early stages of wear or damage.

c. BEFORE INSPECTION.—Before beginning any inspection, consult the Airplane Flight Report (Form 1-A) and the Maintenance Inspection Record (Form 41-B) to determine the reported current status of the airplane. Then proceed with the checks shown in figures 5-28A to 5-51.

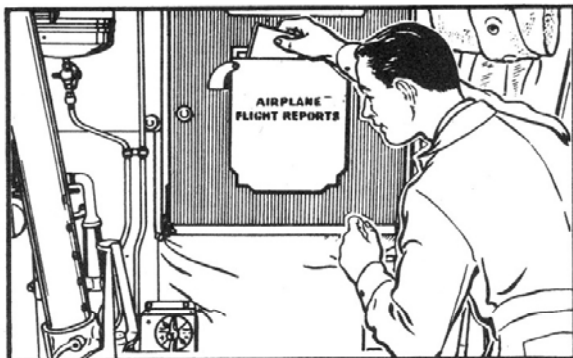


Figure 5-28A

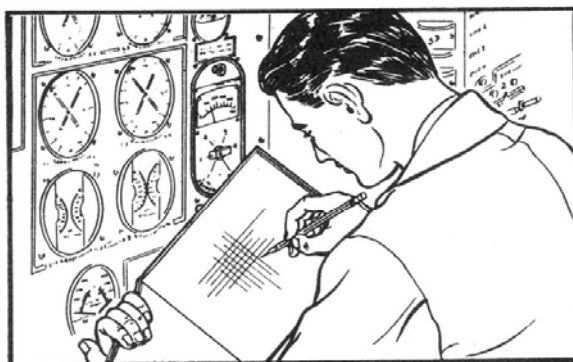


Figure 5-28B

d. PREFLIGHT CHECK PROCEDURE.—The following tests are made without removing the dust cover of the receiver-indicator, since in this check, it is only necessary for the operator to observe that the correct trace patterns appear on the indicator screen at each position of the "FUNCTION" switch. The following scope illustrations show the trace patterns with received signals.

Step 1. First, check the airplane number entered on the forms. Make sure these forms refer to the airplane being inspected. Make certain the forms are up to date and complete. If they are not, either make the necessary entries to complete them, or find out why the entries have not already been made. See if the inspection status and time record indicate that a routine inspection is due. If so, and the inspection cannot be made, enter the correct symbol to indicate omission of the inspection. A red dash indicates "Required Inspection Not Made."

Step 2. Note the *Status Today* of the airplane as indicated by the forms. A red cross indicates the existence of a dangerous condition. The airplane must be grounded, and may not be flown until the condition is corrected. A red diagonal indicates the existence of a condition which must be corrected before the airplane can be considered in first class condition. If the condition cannot be corrected at once, the airplane may be flown provided an exceptional release is executed by either the squadron engineering office, or the pilot of the airplane.

(1) POWER SUPPLY VOLTAGE CHECK.—See section II, paragraph 2b, Steps 1 to 8 inclusive.

(2) "ON" PROCEDURE.—See section III, paragraph 3a(1), Steps 2 to 6 inclusive.

(3) "FUNCTION" SWITCH POSITION "1."

Step 1. Turn the "FUNCTION" switch on the front panel to position "1."

Step 2. Observe the traces on the indicator screen.

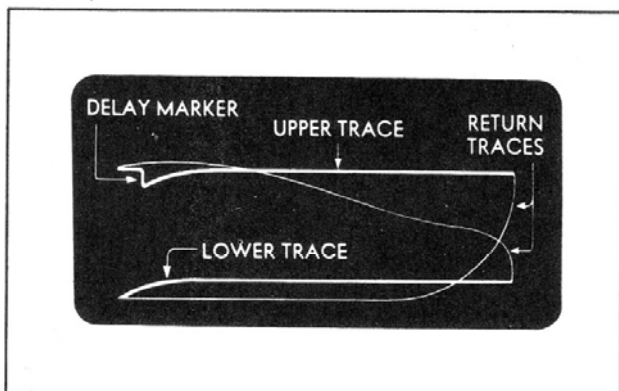


Figure 5-28C

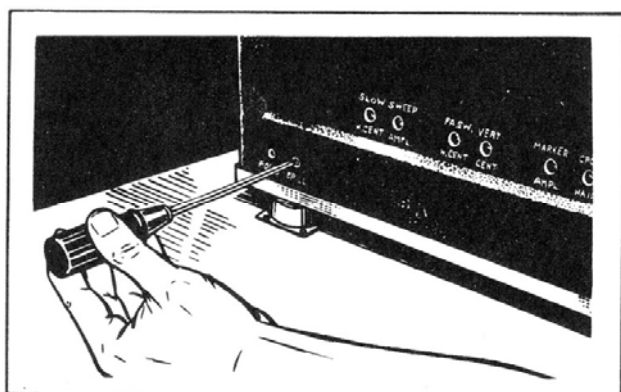


Figure 5-29

Step 3. If no traces have appeared, adjust the "BRILL." screw driver control on the left hand side of the receiver-indicator until the traces appear.

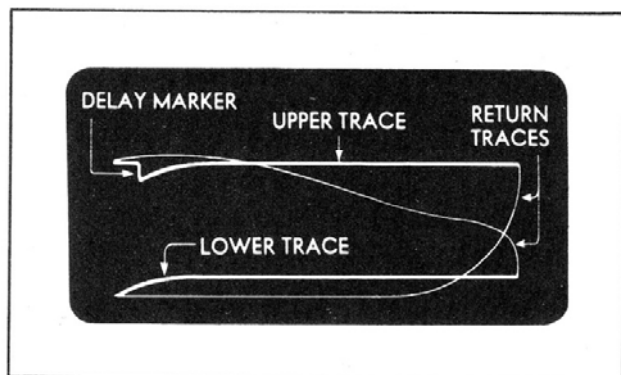


Figure 5-30

Step 4. Note that the delay marker appears on the trace. The absence of the marker indicates faulty equipment (refer to paragraph 12c, this section).

Step 5. Turn the "COARSE DELAY" control and observe the movement of the variable delay marker.

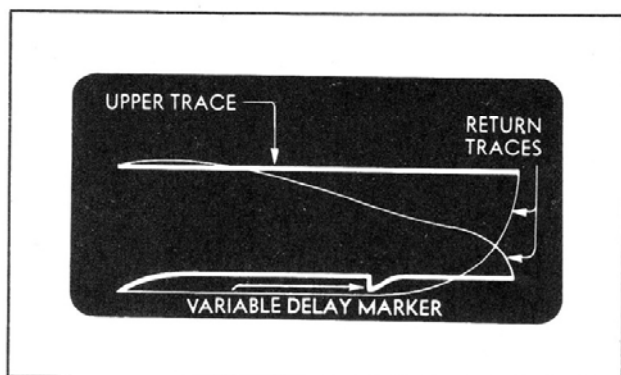


Figure 5-31

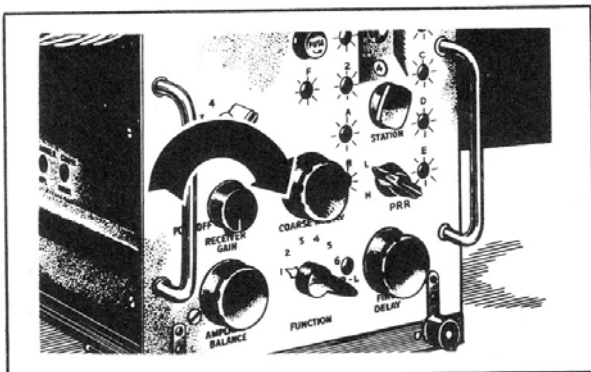


Figure 5-32

Step 6. Turn the "RECEIVER GAIN" control to the maximum clockwise position.

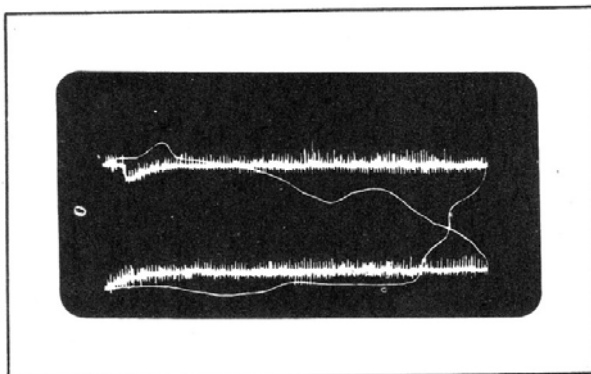


Figure 5-33

Step 7. Observe the height of the *grass* and note that it is not less than 1/4-inch as shown in figure 5-33.

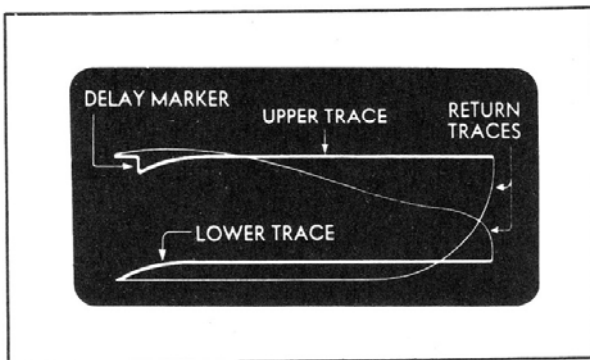


Figure 5-34

Step 8. Be sure that the trace amplitude is correct. (See figure 5-34.) If the length of the trace is too long or too short, . . .

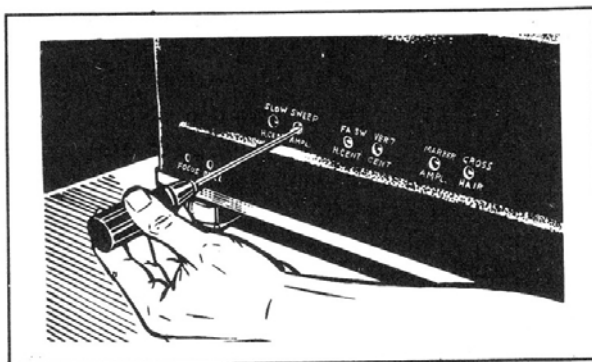


Figure 5-35

Step 9. . . . adjust the "SLOW SWEEP AMPL." screw-driver control on the left side panel until the traces assume their normal length (approximately 1/2" from each edge of the tube).

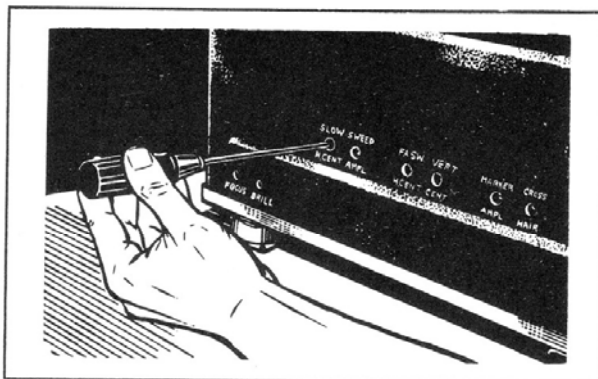


Figure 5-36

Step 10. Examine the traces to see that they are centered *horizontally*. If the traces are not centered horizontally, adjust the "SLOW SWEEP H. CENT." screw-driver control on the left hand side of the receiver-indicator until the traces are properly centered.

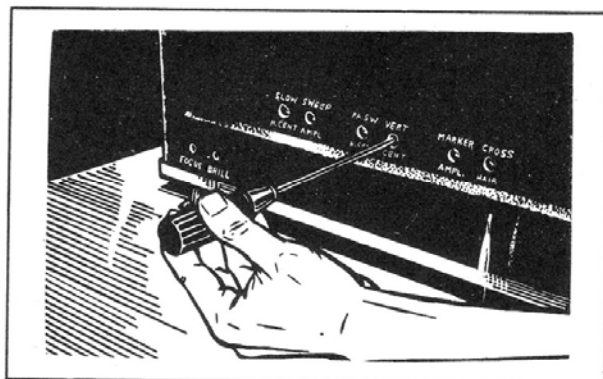


Figure 5-37

Steps 9 and 10 may have to be repeated and coordinated until the amplitude and centering of the traces are correct.

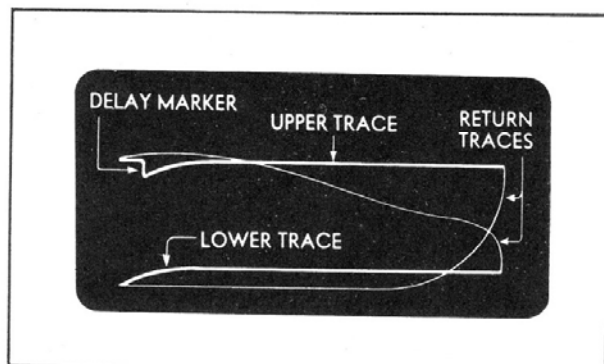


Figure 5-38

Step 11. Check the traces to see that they are centered *vertically*. If the traces are off center vertically, adjust the "VERT. CENT." control on the left hand side of the receiver-indicator until the traces are correctly centered as illustrated in figure 5-38.

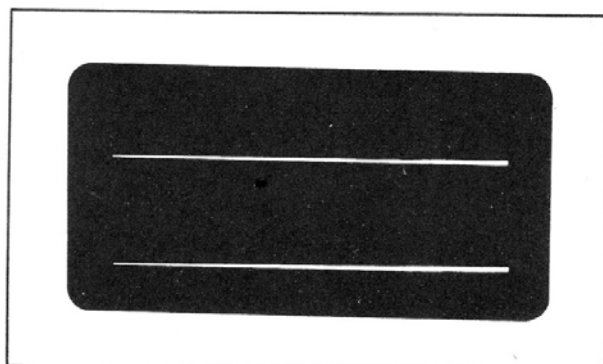


Figure-5-39

(4) "FUNCTION" SWITCH POSITION "2."

Step 1. Turn the "FUNCTION" switch to position "2." Observe the traces on the indicator screen.

Step 2. If no traces have appeared, proceed as outlined in paragraph 4d(3), this section, Step 3.

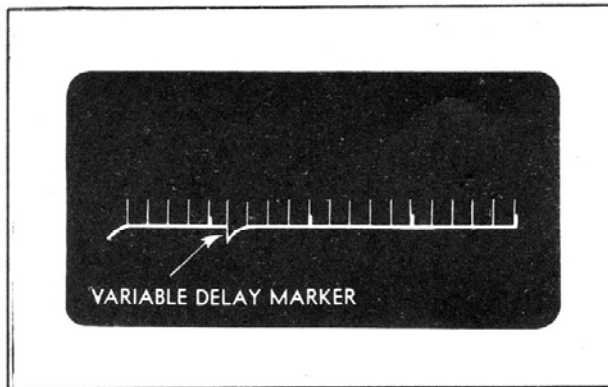


Figure 5-48

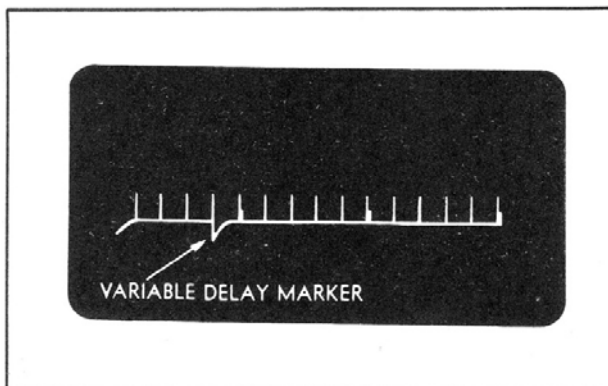


Figure 5-49

Step 5. With the "PRR" switch set at "L" turn the "COARSE DELAY" control to the maximum counterclockwise position and the "FINE DELAY" control to the maximum clockwise position. The variable delay marker should now be located between 13,000 and 15,000 microseconds from the extreme right end of the trace.

Step 6. With the "FINE DELAY" control in the same position as in Step 5, turn the "COARSE DELAY" control to the maximum clockwise position. The variable delay marker should not appear on the trace.

Step 7. With the "COARSE DELAY" control turned to the maximum counterclockwise position, the "FINE DELAY" control to the maximum clockwise position, and the "PRR" switch set at "H," the variable delay marker should be located between 15,000 and 12,000 microseconds from the extreme right end of the trace.

Step 8. With the "FINE DELAY" control in the same position as in Step 5, turn the "COARSE DELAY" control to the maximum clockwise position. The variable delay marker should not appear on the trace.

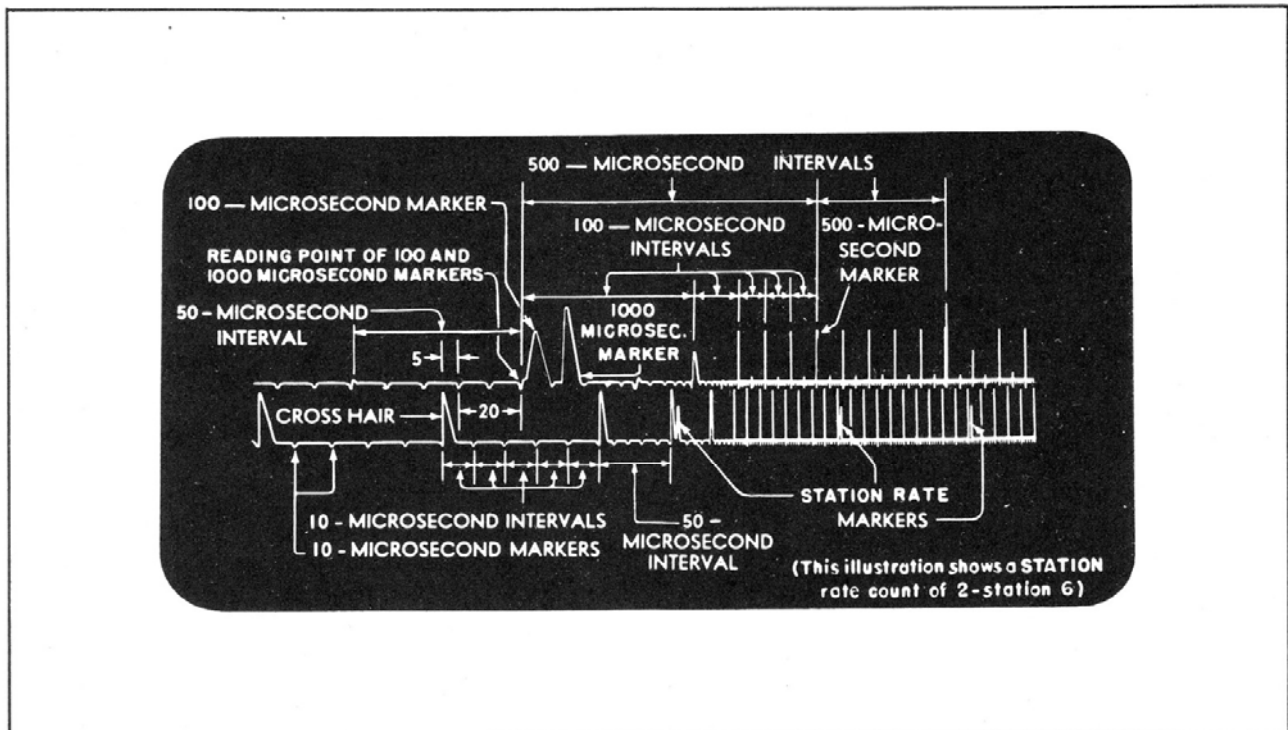


Figure 5-50

(7) "FUNCTION" SWITCH POSITION "5."

Step 1. Turn the "FUNCTION" switch to position "5" and observe the traces on the indicator screen.

Step 2. If the pattern is blurred so that the markers cannot be easily read, adjust the "FOCUS" control on the left hand side of the receiver-indicator until the image is clearly defined. Note that the heights of the markers are such that they may be identified readily. If the heights of the markers are not correct, adjust the "MARKER AMPL." screw-driver control on the left hand side of the receiver-indicator.

Step 3. Notice the position of the cross hair in relation to the upper trace. If the distance between the peak of the cross hair and the upper trace is not as shown in figure 5-50, adjust the "CROSS HAIR" screw-driver control on the left hand side of the receiver-indicator.

Step 4. Read the lower trace and count five 10-microsecond intervals between the 50-microsecond markers.

Step 5. Read the upper trace and count two 50-microsecond intervals between the 100-microsecond markers.

Step 6. Read the upper trace and count five 100-microsecond intervals between a 500-microsecond marker and a 1000-microsecond marker.

Step 7. Read the upper trace and count two 500-microsecond intervals between the 1000-microsecond markers.

Step 8. Set the "STATION" rate switch at "0" and count the number of 50-microsecond intervals between the cross hair and the first "STATION" rate marker. Repeat this operation for the other "STATION" rate settings "1" to "7," inclusive. The counts observed must agree with the following table.

"STATION" Rate Switch Setting	50-Microsecond Intervals
0	8
1	7
2	6
3	5
4	4
5	3
6	2
7	1

Step 9. With the "STATION" rate switch set at position "4," move the "LEFT-RIGHT" switch to "RIGHT" and count two 50-microsecond intervals between the cross hair and the first "STATION" rate marker.

Note

Paragraphs 4d(7), Steps 1 to 9 inclusive, must be duplicated with the "PRR" switch set at "H" or "L."

Step 10. Set the "FUNCTION" switch to position "4." Turn the "FINE DELAY" control to the maximum clockwise position and turn the "COARSE DELAY" control until the delay marker is located between 5000 and 5500 microseconds.

Step 11. Set the "FUNCTION" switch to position "5." Make a *fine* reading.

Step 12. Turn the "FUNCTION" switch to position "4." Turn the "FINE DELAY" control to the maximum counterclockwise position. Make a *coarse* reading.

Step 13. Turn the "FUNCTION" switch to position "5." Make a *fine* reading.

Step 14. Using the readings obtained in Steps 10 and 11, and 12 and 13, the difference in microseconds should equal approximately 950 microseconds, plus or minus 100 microseconds, otherwise adjust the "FINE DELAY" screw-driver adjustment on the right hand side of the indicator.

(8) "FUNCTION" SWITCH POSITION "6."—Turn the "FUNCTION" switch to position "6" and observe the trace on the indicator screen.

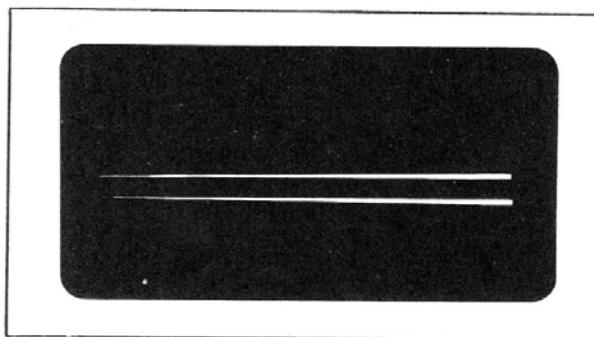


Figure 5-51

(9) SHOCK MOUNT CHECK.—Inspect the shock mount and its ground strap to be sure that they are fastened securely to the airplane. See that the receiver-indicator is fastened securely to the shock mount by means of the two spring plungers inserted in the rear of the shock mount. The two knurled nuts, located at the front of the shock mount must also be tightened firmly to the two hooks on the front panel of the receiver-indicator.

(10) PILOT LIGHT CHECK.—Turn the power on by rotating the "RECEIVER GAIN" control clockwise. If the "STATION" rate window is not illuminated, while a trace pattern appears on the indicator screen, replace the pilot lamp.

(11) LORAN SIGNALS CHECK.—If LORAN signals are available, make a *fix*, as outlined in section III, paragraph 3a(1), (2), (3), and (4).

5. 100-HOUR TESTS.

- Check the tubes. (Identify each tube and if satisfactory, return to its original socket.)
- Visually check the terminal boards and all the other components of the receiver-indicator for decomposition or overload.
- Check for intermittent switch operation.
- Check for and tighten all loose parts, wires, and connections.
- Check both of the rectified output voltages. (See figure 8-4.)

f. Check the voltage of the regulated power supply. (Refer to paragraph 8b, this section.)

g. Align the counters and the "STATION" rates. (Refer to paragraph 8d(2), (3), this section.)

b. Adjust the "BRILLIANCE," "FOCUS," "CENTERING," and "AMPLITUDE" of the sweeps. (Refer to paragraph 8c, this section.)

i. Adjust the "COARSE DELAY M.V." ranges. (Refer to paragraph 8c(2), this section.)

j. Adjust the "FINE DELAY M.V." ranges. (Refer to paragraph 8c(2), (3), this section.)

k. To check the receiver proceed as follows.

(1) Check the stage gains and, if they are low, realign the controlling circuits. (Refer to paragraphs 8e and 12d(1), this section.)

(2) Check the frequency. If the frequency is over 10 kilocycles off from the specified frequency, realign the oscillator and the r-f stage. (Refer to paragraph 8e(4), this section.)

(3) Realign the antenna circuit to the center of the pass band. (Refer to paragraph 8e(4)(f) and 8e(4)(g), this section.)

l. Make all preflight tests. (Refer to paragraph 4, this section.)

6. INTERMITTENT OPERATION AND INTERFERENCE CHECK.

a. Check for intermittent operation and noise which may be caused by loose switches, loose or faulty sockets, plug contacts, defective tubes, broken parts or wiring, loose ground straps or loose mounting of the equipment in its shock mounts. With the equipment in operation, and the units, tubes, and components properly mounted and connected, examine all probable circuit elements to locate the faulty part and correct the trouble. Replace a tube that causes intermittent operation even though a tube tester shows it to be in good condition. (Tube testers do not always register the defects of microphonic tubes.) Noise caused by intermittent tubes may show up as increased noise on the trace when the equipment is vibrated while the airplane engine is running. The operator should examine and successively replace each tube in the receiver-indicator until the noisy tube is located and replaced.

b. Check for static interference, generated by the electrical system of the airplane, which appears as excess grass on the pattern when the antenna is connected and the "FUNCTION" switch is set at position "1." This interference greatly reduces the effective range of Radar Set AN/APN-9 and must be eliminated whenever possible.

7. OPERATIONAL CHECK USING TEST SET TS-251/UP.

a. PRELIMINARY. (See figures 8-31, 8-32, and 8-33.)

(1) Remove Test Set TS-251/UP chassis from carrying case.

(a) Loosen 4 knurled screws.

(b) Pull forward.

(2) Check link (bottom of chassis) for position corresponding to available voltage (80 volts, 115 volts, or 230 volts at 50 to 1600 cycles per second).

(3) Replace chassis in carrying case.

(4) Connect power Cord CX-404/UP and antenna Cord CG-221/UP. (See figure 8-33.)

b. OPERATION.

(1) Turn "POWER" switch to "ON" at Radar Set AN/APN-9.

(2) Turn "ON-OFF" switch to "ON" at Test Set TS-251/UP (dial lights up).

(a) Turn "PULSE CW" switch to "PULSE."

(b) Turn "OUTPUT" switch to "1V."

(c) Turn "CHANNEL" switch to correspond to channel switch on Radar Set AN/APN-9 (allow 3 minutes to warm up).

(3) Set the following controls on the radar set.

(a) Set "FUNCTION" switch to position "1."

(b) Set "PRR" to "L" position.

(c) "STATION SELECTOR" switch to position "4."

(d) Adjust "RECEIVER GAIN" control until pulses appear about 1 inch high.

(e) Adjust "DRIFT" control until pulses are almost stationary.

(4) Steps (d) to (e) above should result in 12 pulses appearing on the screen of the indicator.

(5) Take delay readings between pulses. These delay readings should correspond to the delay readings in microseconds in line with "PRR," "L" on the chart appearing on the front panel of Test Set TS-251/UP. No attempt should be made to take a delay reading of "ZERO."

(6) Check action of "LEFT-RIGHT" switch on the front panel of the indicator. Switch should move pulses left or right in "FUNCTION" position "1," "2," "3" and "4."

(7) Flip "PRR" switch on the radar set to "H" position and "STATION" switch to position "3." Turn "DRIFT" control until pulses are almost stationary. Nine pulses should be visible on the scope of the radar set.

(8) Take time delay readings between pulses. These delay readings should correspond to the delay reading in microseconds in line with the "PRR" "H" column on the front panel of Test Set TS-251/UP.

(9) Turn the "OUTPUT" switch on Test Set TS-251/UP to the "15 μ V" position. Advance the "GAIN CONTROL" on Receiver-Indicator R-65/APN-9 until the pulses are visible. Pulses one or more inches in height should be seen on the screen of Radio Set AN/APN-9 before noise is evident on the cathode ray tube sweep. Make this check on all channel positions if possible.

8. ALIGNMENT PROCEDURE.

a. USE OF TEST OSCILLOSCOPE.—In order to observe the operation of Receiver-Indicator R-65/APN-9 by means of an RCA-158 oscilloscope without materially

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affecting the operation of the receiver-indicator, a resistor-capacitor combination must be placed in series with the scope. The resistor (which should be approximately 10 megohms) is shunted by a small capacitor of approximately one micromicrofarad (a twisted pair of insulated wires may be used).

By observing a square wave, the operator may cut the twisted pair of insulated wires until the correct capacity is obtained.

Note

The effect of too small a capacitor is to round off the corners of the square waves. (See figure 5-52.) On the other hand, too large a capacitor will produce peaks at these points. (See figure 5-53.) Figure 5-54 shows both the correct and incorrect wave shapes.

The network should be kept with the test scope so that the wave shapes in high impedance circuits may be observed without materially affecting their operation. The wave shapes given in figures 8-7 and 8-8 are obtained by using such a network with an RCA-158 test scope.

The fidelity of the test scope is not sufficient to produce authentic waves, but the faulty operating component of the equipment may be located by observing the difference between the waves on the test scope screen and those given in figures 8-7 and 8-8.

b. GENERAL ALIGNMENT.—To obtain a preliminary alignment of Receiver-Indicator R-65/APN-9 when the adjustment controls are completely misaligned, observe the following procedure, unless the operator can determine and reset the misaligned controls from information obtained by observing the patterns on the indicator screen with the "FUNCTION" switch in its various positions. Before making these adjustments, adjust R-260 (regulated power supply) to produce a regulated supply voltage of 210 volts.

(1) PRELIMINARY ALIGNMENT PROCEDURE.—Using the RCA-158 scope with the external networks described in paragraph 8a, this section, make successively the connections specified and observe the wave shape. If incorrect, make the required adjustment, otherwise proceed to the next circuit.

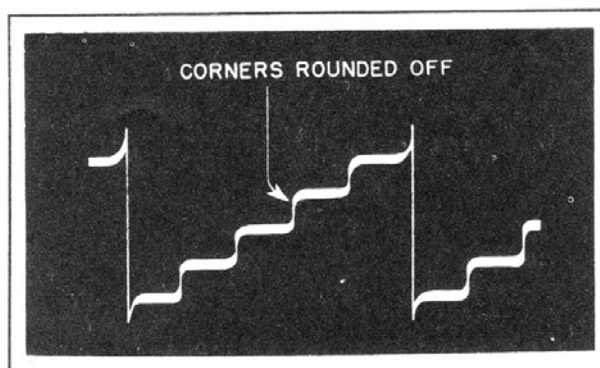


Figure 5-52. Incorrect Wave Shape

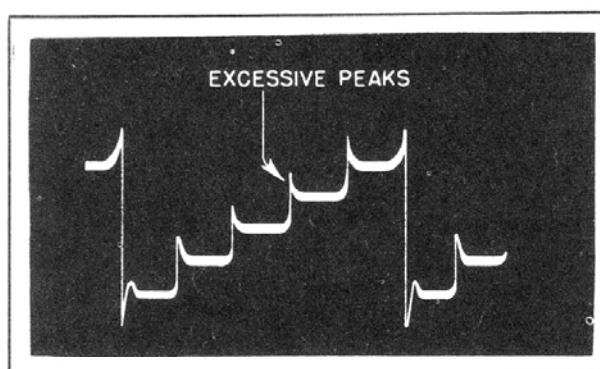


Figure 5-53. Incorrect Wave Shape

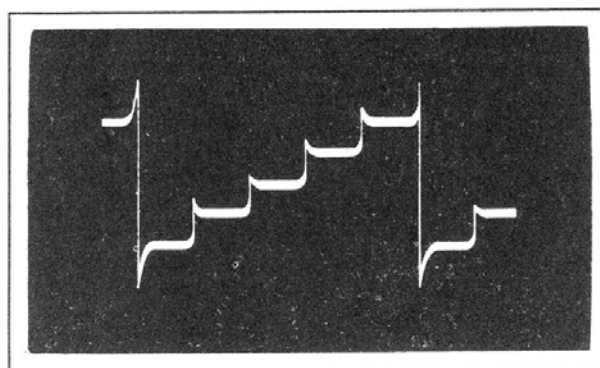


Figure 5-54. Correct Wave Shape

"PRR"	Circuit	Connect Scope To:		Adjust	Effect
		Tube Socket	Term.		
L	Crystal plate	X-107	5	L-102	Crystal Operation (See fig. 8-8.)
L	Crystal grid	X-107	5	L-101	Caution See par. 8d(1)(b), this section, before adjusting. (See fig. 8-8.)
L	50-microsecond blocking osc.	X-108	5	A	(See fig. 8-8.)
L	100-microsecond blocking osc.	X-108	1	R-134	(See fig. 8-8.)
L	500-microsecond blocking osc.	X-113	4	B	(See fig. 8-8.)
L	5000-microsecond blocking osc.	X-115	8	C	(See fig. 8-8.)
H	15,000-microsecond blocking osc.	X-117	8	D	(See fig. 8-8.)
L	20,000-microsecond blocking osc.	X-117	8	E	(See fig. 8-8.)

Note

Attempts to align the crystal grid inductance contrary to the instructions given above may result in misalignment to an extent where the "STATION" rates will be one "STATION" rate high for all settings of the "STATION" rate switch. Such misadjustment can be recognized by its effect on the action of the "LEFT-RIGHT" switch, since the pulse drift to either side will be about 10 times the normal speed. Furthermore, the "DRIFT" control setting will be extremely critical.

(2) COUNTER ADJUSTMENTS.—All alignment adjustments in the counter circuits are of the step type. Since the equipment is expected to work under widely varying conditions of temperature and humidity, it is of the utmost importance that the alignment procedure results in all adjustments being exactly centered within the range where they provide the correct performance. Since the adjustments are somewhat interdependent, the counter must be aligned in the correct sequence. Therefore, no counter should be aligned without realigning the entire chain of counter circuits.

Before realigning a counter, carefully inspect the components of this particular circuit to determine whether they have been overloaded or otherwise damaged. The tubes affecting the circuit should also be checked.

Make the adjustments listed below by connecting a high resistance voltmeter to the indicated terminal and adjusting the voltage to the center of the voltage range over which the correct count is indicated by the cathode-ray traces. Since the counter adjustment is to be set within about one-quarter of a volt of the correct value, it is necessary to use an adjustable "bucking" battery so that the voltages can be read on a low range meter scale, in order to obtain an accurate voltmeter reading. Only vacuum tube voltmeters are of sufficiently high resistance to be used for this purpose. Such meters as the Voltomyst, Jr. will prove satisfactory.

Note

Place a 50,000-ohm to 100,000-ohm potentiometer across a 45-volt or 90-volt B-battery. Connect one lead to ground and the other to the voltmeter. Connect the test probe to the voltmeter. Arrange the polarity of the connections so that the B-battery is effectively "bucking" the voltage in the circuit under test. This is zero the voltmeter.

(a) 50-MICROSECOND COUNTER.—Connect voltmeter lead to junction of R-130 and R-131, with the voltmeter set to its 100-volt range. Adjust the bucking voltage, so that the initial reading is as near as possible in the center of its range. Set "STATION" rate to "O" and "PRR" rate to "H." Adjust the control marked "A" on the front panel to the low and high edges of the correct 5 count and note the corresponding voltmeter

readings. Adjust "A" until the voltmeter reads the average of the two voltages found above.

(b) 5000-MICROSECOND COUNTER.—Proceed as specified for the 50-microsecond counter except that the voltmeter should be connected to terminal number 4 on terminal board E-106, with its range set for 10 volts. Adjust the control marked "C" for a correct 5 count.

(c) 15,000-MICROSECOND COUNTER.—Proceed as specified for 5000-microsecond counter except that the voltmeter should be connected to terminal 8 on S-105 and the control marked "D" should be adjusted for a correct 3 count.

(d) 20,000-MICROSECOND COUNTER.—Proceed as specified for the 15,000-microsecond counter except that the "PRR" rate should be set to "L" and the control marked "E" should be adjusted for the correct 4 count.

(e) 100-MICROSECOND COUNTER.—In adjusting this counter, the trace may change, due to its effect on the 500-microsecond counter. This may result in serious errors unless the operator proceeds as outlined below:

Connect the voltmeter, set for the 30-volt range, to terminal number 1 on terminal board E-106, and with the "STATION" rate adjusted to "1" and the "PRR" rate to "L," adjust R-134 on the back apron of the top chassis to its low edge of the stable range. Next center adjustment "D" mechanically within its stable range and reset R-134 to its low edge of the stable range. Note the voltmeter reading. Then set R-134 to its high edge of the stable range. Recenter adjustment "D" mechanically, then reset R-134 as before. Note the voltmeter reading. Set R-134 to provide a voltage equal to the average of the two voltmeter readings.

(f) 500-MICROSECOND COUNTER (PRELIMINARY).—Connect the voltmeter lead to terminal number 6 on terminal board E-106, with the voltmeter adjusted to its 3-volt range. Adjust the control marked "B" to the low edge of its stable range. Adjust the bucking voltage to provide a reading of 1.5 volts. Readjust "B" to increase this reading to 1.8 volts.

(3) STATION RATE ADJUSTMENTS.—Referring to the trace indication as shown on figure 5-57, the station rate adjustments are made as follows:

(a) STATION RATE 2.—With the "PRR" switch set at "L" and the "STATION" rate set at "2," adjust the adjustment marked "2" as far clockwise as possible for a correct station rate indication of 6. (Count 2.)

(b) STATION RATE 4.—With the "PRR" switch set at "L" and the "STATION" rate set at "4," adjust the adjustment marked "4" as far clockwise as possible for a correct station rate indication of 4. (Count 4.)

(c) RIGHT ADJUSTMENT.—With the "PRR" switch set at "L," the "STATION" rate set at "4" and the "RIGHT-LEFT" switch turned to "RIGHT," adjust

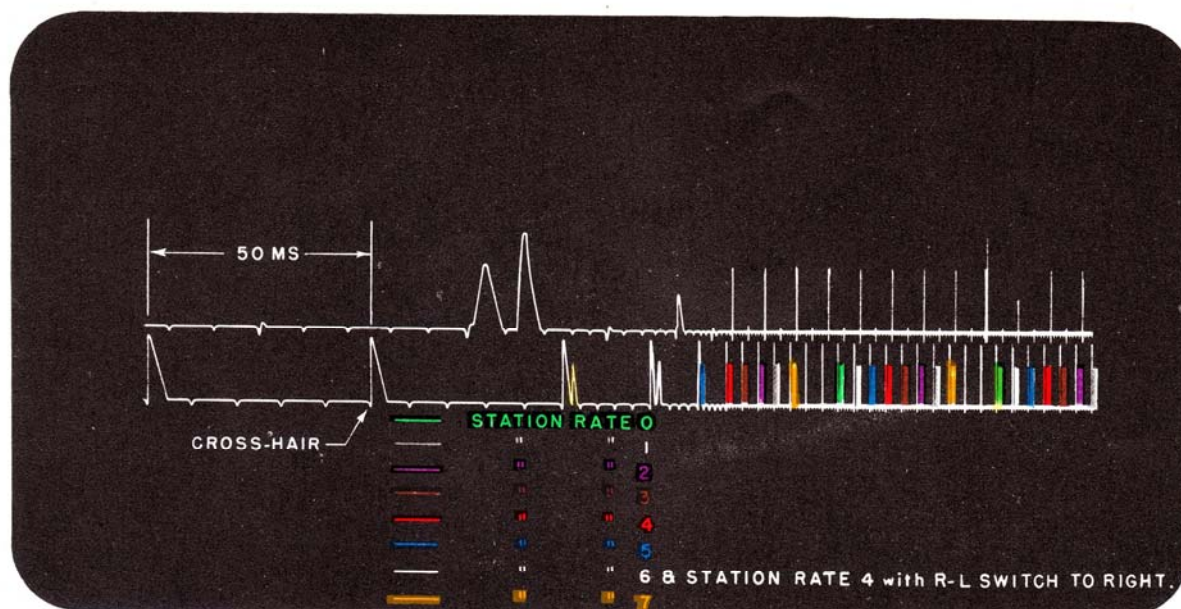


Figure 5-57. Station Rate Count

the adjustment marked "R-L" as far clockwise as possible for a correct station rate indications of 6. (Count 2.)

(d) STATION RATE 6.—With the "PRR" switch set at "L" and the "STATION" rate set at "6," adjust the adjustment marked "6" as far clockwise as possible for a correct station rate count indication of 6. (Count 2.)

(e) 500-MICROSECOND COUNTER (FINAL).—With the voltmeter lead connected to terminal number 6 on the terminal board E-106, adjust the voltmeter range to 10 volts. Set the "STATION" rate to "7" and the "PRR" rate to "L." Adjust the bucking battery voltage so that all readings are within the voltmeter range. Adjust the control marked "B" on the front panel to the high and low edges of the stable correct pattern, and note the corresponding voltmeter readings. For indications of a stable pattern, observe the five hundred-microsecond markers on the lower trace. Adjust "B" until the voltage reading equals the average of the two voltages found above.

e. RADIO RECEIVER CIRCUIT ALIGNMENT.

(1) EQUIPMENT REQUIRED.

(a) SIGNAL GENERATOR.

CAUTION

Be sure that the frequency calibration of the generator is correct.

(b) Output Meter—RCA Voltomyst Jr., 165.

(c) Capacitor—approximately 500 micromicrofarads.

(d) Resistor—50 ohms.

(2) OPERATION OF EQUIPMENT.—Connect the output meter to read the output of the second detector, and feed the output of the signal generator to the input of the stage to be adjusted. Operate the output meter on the 10-volt scale with a nominal signal indication of five volts. Whenever conditions are changed, adjust the generator output to return to this working level. To obtain steady noise-free meter readings, keep the output level of the generator as low, and the "RECEIVER GAIN" control as high, as local noise conditions permit. As a check for noise indication on the meter, be sure that the meter reading does not exceed one volt when no signal is applied to the input.

(3) INTERMEDIATE FREQUENCY ALIGNMENT.—Never attempt intermediate frequency alignment unless it is positively known to be at fault.

Note

Complete re-alignment is necessary only if the set has been improperly aligned. When the individual components are changed, adjust only the transformers involved. Do not completely re-align each time the r-f system is realigned.

(a) EQUIPMENT REQUIRED.—A signal generator, an output meter, and a 500-micromicrofarad, mica-capacitor are required equipment for alignment.

(b) CONNECTIONS.—Connect the meter to pin 1, V-106, so that it will indicate a negative voltage. Connect the *high side* of the signal generator to the grid pin of the tube which feeds the transformer to be aligned, and the *low side* to the chassis.

(c) PROCEDURE.—Set the signal generator frequency at 1100 kilocycles, and adjust the "OUTPUT"

<i>Trouble</i>	<i>Check</i>	<i>Reference</i>
One trace	EJ and EJ follower	Sec. IV, par. 4c(2)(a) Sec. V, par. 12c
No delay markers	Differential mixer	Sec. IV, par. 4c(2)(d) Sec. V, par. 12c
No variable delay marker or multiple variable delay markers	Counter, coarse delay, fine delay, and differential mixer	Sec. IV, par. 4b Sec. IV, par. 4c(2)(b) Sec. IV, par. 4c(2)(c) Sec. IV, par. 4c(2)(d) Sec. V, par. 12c
Wrong indication on one "PRR" rate	Counter including S-105, coarse delay	Sec. IV, par. 4b Sec. IV, par. 4c(2)(b) Sec. V, par. 12b Sec. V, par. 12c Sec. V, par. 11
Excess flickering trace	Counter alignment. Power supply filtering or regulated supply	Sec. IV, par. 4b Sec. IV, par. 5d Sec. V, par. 12b Sec. V, par. 12a
Flickering variable delay marker	Regulated power supply and voltage adjustment	Sec. IV, par. 4d Sec. V, par. 12a
No grass with receiver gain control at maximum	Receiver	Sec. IV, par. 4a Sec. V, par. 12d

b. "FUNCTION" SWITCH POSITION "2."

<i>Trouble</i>	<i>Check</i>	<i>Reference</i>
No traces	Fast sweep	Sec. IV, par. 4c(2)(f) Sec. V, par. 12c
No change in noise with setting of amplitude balance control (antenna connected)	1st squaring amplifier; 2nd squaring amplifier; D-C restorer; radio receiver	Sec. IV, par. 4c(2)(i) Sec. IV, par. 4a Sec. V, par. 12c Sec. V, par. 12d
No trace separation	1st squaring amplifier; 2nd squaring amplifier; coarse delay adjustment	Sec. V, par. 12c Sec. IV, par. 4c Sec. IV, par. 4c(2)(b) Sec. V, par. 8c(2)

c. "FUNCTION" SWITCH POSITION "4."

<i>Trouble</i>	<i>Check</i>	<i>Reference</i>
Wrong marker indication or unsteady markers	Counter alignment	Sec. IV, par. 4b Sec. V, par. 12b Sec. V, par. 8d
Delay marker in wrong location	Coarse delay alignment or counter alignment	Sec. IV, par. 4c(2)(b) Sec. IV, par. 4b Sec. V, par. 12c Sec. V, par. 12b Sec. V, par. 8c(2) Sec. V, par. 8d
Two traces	"BRILLIANCE" restorer and blanking voltage applied in position 4	Sec. IV, par. 4c(2)(b) Sec. V, par. 11

d. "FUNCTION" SWITCH POSITION "5."

<i>Trouble</i>	<i>Check</i>	<i>Reference</i>
No 10-microsecond marker	10-microsecond blocking osc. and S106D	Sec. IV, par. 4b(2)(e) Sec. V, par. 12b Sec. V, par. 9 Sec. V, par. 11
No 50-, 100-, or 1000-microsecond markers	Marker mixer	Sec. IV, par. 4c(2)(j)
No vertical deflection between sweeps with any setting of cross hair adjustment	1st squaring amplifier and marker mixer	Sec. IV, par. 4c(2)(j) Sec. V, par. 12c

<i>Trouble</i>	<i>Check</i>	<i>Reference</i>
Wrong marker indication or unsteady markers	Counter alignment	Sec. IV, par. 4b Sec. V, par. 12b Sec. V, par. 8d
Wrong station rate indication	Counter and station rate alignment	Sec. IV, par. 4b Sec. V, par. 12b Sec. V, par. 8d
Sweeps dissimilar with delay readings under 10,000 "PRR-L" or 8,000 "PRR-H"	1st squaring amplifier; 2nd squaring amplifier; fast sweep	Sec. IV, par. 4c(2)(i) Sec. IV, par. 4c(2)(f) Sec. V, par. 12c

If the fault in the equipment cannot be determined from the trouble location chart, make a visual inspection to uncover obvious faults. If the fault is not localized, attempt an alignment as outlined in paragraph 8b. Any circuit which cannot be made to operate as indicated must be at fault. Locate the inoperative stage and then check the tubes before checking the voltage and wave shapes. After a circuit in the equipment has been repaired, or a tube changed, the equipment should be completely aligned, unless it is certain that the repair has not affected any other circuit in the equipment.

11. RANGE SWITCHES.

Range switches, except S-103 which is shown in the neutral position, are shown on the schematic diagram (see figure 8-10) in their maximum counterclockwise positions. All switches are shown as they appear from the knob end. For each switch position, the rotors turn 30 degrees, or the angular rotation equal to that between adjacent terminals. Note that two levels of contacts and two widths of rotor blades are used. The small notch in the center along the side of the actuating shaft hole orients the switch section with respect to the other sections of the switch. Some dummy terminals on the actual switches are not shown on the schematic diagram.

To clarify the reading of the "FUNCTION" switch, figure 5-58 shows S-106F "REAR" as it appears in all positions of the "FUNCTION" switch.

12. MAINTENANCE REPAIRS.

a. POWER SUPPLY.—Although the power supply furnishes power for the operation of the entire in-

strument, the voltages obtained depend upon the rest of the equipment. (See section IV, paragraph 4d.) To determine the trouble which results in a fuse failure, proceed as follows:

Remove both the high and low voltage rectifiers to eliminate all the rectified voltage load on the power supply. If the short circuit still exists, the trouble may be traced further by removing the general filament supply leads. If the trouble does not appear after the removal of the rectifiers, its location is determined by replacing them one at a time. When the low voltage rectifier is at fault, remove the 6Y6G (V-130) tube. If this operation removes the trouble, a short exists along the regulated supply leads. The exact trouble may be located by means of the voltage charts, resistance charts, and schematic diagrams. (See figures 8-1 to 8-6 inclusive, and 8-10.)

b. TIMER.—All blocking oscillators after the 50-microsecond timer require pulses from the preceding blocking oscillator for their operation; consequently, an oscilloscope method for trouble location in the counter is desirable. (See section IV, paragraph 4b.) For this reason, a procedure starting at the crystal oscillator and proceeding toward the final blocking oscillator is recommended. Obviously, the first circuit which does not perform according to the wave chart (see figure 8-8) is at fault, and the components should be examined in this stage, using a resistance chart, voltage chart, and schematic diagram to locate the exact trouble. (See figures 8-2, 8-5, 8-6, and 8-10.)

Check the entire timer with the "STATION" switch set at the "O" position before looking for trouble in

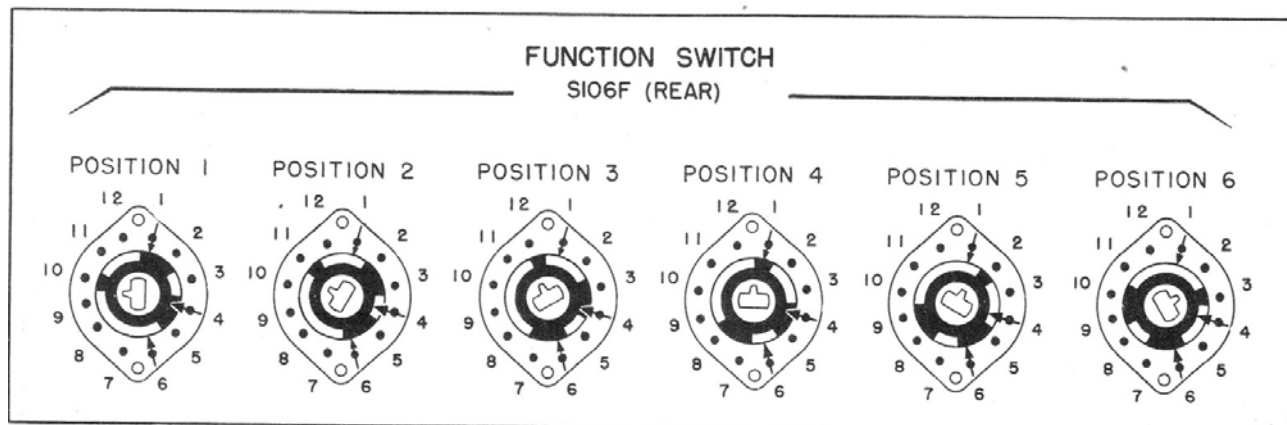


Figure 5-58. Rear of S-106F (Function Switch)

the feed-back circuit. If the timer operates correctly on position "O" of the "STATION" switch, and the feed-back circuits perform incorrectly, check the feedback circuit.

Replace a tube which does not perform substantially in accordance with the wave charts or fails to operate correctly at low line voltages. The measurements of a tube in a tube tester are not necessarily a good indication of whether a tube is satisfactory for use in the timer.

Because of the interaction of the various timers, a complete alignment should be carried out to ensure proper stability, if components or tubes have been replaced. Since the stability of the timer is controlled directly by its alignment, and the circuits are expected to perform continuously under varying atmospheric conditions, align the circuit carefully.

The count on which a blocking oscillator will fire is approximately proportional to its cathode bias and the size of the grid storage capacitor. This count is in-

versely proportional to the output of the preceding blocking oscillator and the size of the counter input capacity. A diode that is low in emission may increase the count and cause the circuit to be unstable with changes in the line voltage. If the blocking oscillator itself is a weak tube, it may not reset the counter completely and will not require the same number of steps to fire it. Normally, when a timer stage does not stay in count with a change in the line voltage, the preceding blocking oscillator tube is varying its output and, therefore, must be replaced.

c. DELAY AND DEFLECTION CIRCUITS. (See section IV, paragraph 4c.)—The operation of the delay and deflection circuits is controlled by the timer. Therefore, the timer must be checked before proceeding with the examination of the delay and deflection circuits. Check the operation of these circuits, by observing the patterns on the indicator screen and by checking the circuits referred to in the following chart.

(1) DELAY AND DEFLECTION TROUBLE LOCATION CHART.

(a) "FUNCTION" SWITCH POSITION "1."

<i>Trouble</i>	<i>Check</i>	<i>Reference</i>
No traces	Slow sweep, horizontal amplifier, indicator tube, and connections	Sec. IV, par. 4c(2)(e) Sec. IV, par. 4c(2)(g) Sec. IV, par. 4e
One trace	Pulse rectifier EJ and EJ follower	Sec. IV, par. 4c(2)(a)
No delay markers	Coarse delay, fine delay, differential mixer	Sec. IV, par. 4c(2)(b) Sec. IV, par. 4c(2)(c) Sec. IV, par. 4c(2)(d)

(b) "FUNCTION" SWITCH POSITION "2."

<i>Trouble</i>	<i>Check</i>	<i>Reference</i>
No traces	Fast sweep, "FUNCTION" switch	Sec. IV, par. 4c(2)(f) Sec. V, par. 9 Sec. V, par. 11
One trace	1st squaring amplifier 2nd squaring amplifier	Sec. IV, par. 4c(2)(i)
Bright spots at ends of traces	Brilliance restorer, fast sweep	Sec. IV, par. 4c(2)(h) Sec. IV, par. 4c(2)(f)

(c) "FUNCTION" SWITCH POSITION "5."

<i>Trouble</i>	<i>Check</i>	<i>Reference</i>
Markers not correct	Marker mixer	Sec. IV, par. 4c(2)(j)
No vertical amplitude	Amplitude balance marker mixer	Sec. IV, par. 4c(2)(i) Sec. IV, par. 4c(2)(j)

(2) GENERAL CHECK.—When a general check is desired, follow the procedure outlined below in the order indicated. Correct operation is determined by referring to the wave diagram in figure 8-7. In locating trouble in a particular circuit, refer also to the resistance and voltage charts in figures 8-1, 8-3, 8-4, and 8-10.

(a) PULSE RECTIFIER.—See section IV, paragraph 4c(2)(a).

(b) EJ AND EJ FOLLOWER.—See section IV, paragraph 4c(2)(a).

(c) COARSE DELAY M.V.—See section IV, paragraph 4c(2)(b).

(d) FINE DELAY M.V. AND CLIPPER.—See section IV, paragraph 4c(2)(c).

(e) DIFFERENTIAL MIXER AND CLIPPER.—See section IV, paragraph 4c(2)(d).

(f) FAST SWEEP.—See section IV, paragraph 4c(2)(f).

(g) HORIZONTAL AMPLIFIER.—See section IV, paragraph 4c(2)(g).

(h) SLOW SWEEP.—See section IV, paragraph 4c(2)(e).

(i) AMPLITUDE BALANCE.—See section IV, paragraph 4c(2)(i).

(j) MARKER MIXER.—See section IV, paragraph 4c(2)(j).

(k) BRILLIANCE RESTORER.—See section IV, paragraph 4c(2)(b).

(l) INDICATOR TUBE.—See section IV, paragraph 4e.

In checking a stage, start from its input end and check the wave shapes through the stage to the output.

d. RADIO RECEIVER.

(1) Visually examine the receiver for tubes which are damaged or not properly inserted in their sockets, for broken wiring and loose connections, and for broken, burned, corroded, mouldy or otherwise defective parts. Turn on the equipment and after a five minute warm-up period, feel each tube to ascertain if the filaments are heating.

(2) With the "RECEIVER GAIN" control set near its maximum (clockwise) position, and the "FUNCTION" switch in position "1," a voltage check should approximate the values indicated in figures 8-5 and 8-6.

(3) If discrepancies are found, make resistance checks of the associated parts, using the ohmmeter, and referring to figure 8-2.

(4) If all voltages are normal, but the receiver is inoperative or weak, trace the signal through the receiver circuits. To do this, connect the low side of the modulated signal generator to the chassis and the high side to an insulated probe. Apply the signal to the inputs of successive stages, starting with the detector, and observe the output by means of the amplitude of the modulation pattern on the indicator tube.

(5) Adjust the "RECEIVER GAIN" control at maximum or, after the generator has been connected, to the position in which heavy *grass* begins to appear on the traces. Vary the output of the generator to produce a modulation pattern of convenient amplitude on the indicator without overloading as indicated by excessive *grass*. Measure the stage gain when the input probe is moved from the input of the succeeding stage to that of the stage in question, by determining the amount the generator output attenuator must be changed to produce the same pattern height on the indicator.

(6) If no pattern appears for a stage, or if the stage gain is substantially different from that shown in the following table, this stage of the equipment is defective.

(7) Locate the defective parts using figures 8-2, 8-5, 8-6, 8-9 and 8-10. Replace any defective parts. If the repair work affects the alignment the receiver must be realigned according to paragraph 8e.

Step	Stage	Apply input probe to:	Input frequency	Approximate gain of stage
1	Video	Pin 3—V-106	1100 kc.	—*
2	3rd I-F	Pin 4—V-105	1100 kc.	18
3	2nd I-F	Pin 4—V-104	1100 kc.	25
4	1st I-F	Pin 4—V-103	1100 kc.	25
5	Converter	Pin 8—V-102	R-F	5.5
6	R-F	Pin 4—V-101	R-F	8
7	Antenna	Antenna post through 50 ohms	R-F	9

*Approximately one volt of signal is required at this point to produce a usable amplitude pattern on the indicator.

(8) With the signal applied to the antenna post, turn the "FUNCTION" switch to position "2," and set the "AMPLITUDE BALANCE" control at the center of its range of rotation. The modulation pattern should appear on both traces on the indicator tube. As the "AMPLITUDE BALANCE" control is rotated clockwise, and counterclockwise, the pattern should disappear from the top and bottom traces respectively. If the pattern does not disappear, the wiring of the "AMPLITUDE BALANCE" circuit to the deflection chassis, and the performance of the circuits in the deflection chassis should be checked.

(9) Replace tubes or parts which are suspected of being faulty with identical tube types or parts known to be in good condition. As each individual part is changed, note the effects of the change.

13. MODIFICATIONS IN RADAR SET AN/APN-9.

a. The following changes were made in the circuits of Receiver-Indicator R-65/APN-9 at serial number 501, under order number 1277-Day-44. Change (1) changes the voltage distribution of the high potential voltage divider. Changes (2) to (5), inclusive, were made to facilitate the reading of the time interval between two pulses throughout the range of the amplitude balance control.

(1) To assure proper cutoff of all indicator tubes, the 15,000-ohm resistor, resistor R-307, has been added in series with brilliance-control potentiometer R-263. To make this change, a new lug was added between the case of the brilliance-control potentiometer and the bakelite insulator. Resistor R-264 was removed at lug 3 of the potentiometer and connected to the new lug. The added resistor R-307 was connected between this new lug and lug 3 of the potentiometer. The purple wire was removed from lug 3 of the potentiometer and connected to the new lug.

WARNING

The brilliance-control potentiometer with its case is approximately —1300 volts below the chassis or ground.

(2) Resistor R-103 (680 ohms) was removed between lug 2 of wave trap T-103 and ground, and replaced by a 220-ohm resistor.

(3) Cathode choke coil L-103 was added between the cathode, pin 5, of r-f amplifier tube V-101 (JAN-6SK7) and lug 1 of wave trap T-103. Lug 3 was added to the wave trap and the new choke was connected between this lug and lug 1 of the wave trap. A lead was added to connect lug 3 of the wave trap to the cathode, pin 5, of r-f amplifier tube V-101.

(4) The lead between the screen grid, pin 6 of tube V-101, and the screen grid, pin 4 of converter tube V-102 (JAN-6SA7), was removed and replaced by 680-ohm resistor R-306.

(5) Capacitor C-244 was added between the screen grid, pin 4, of tube V-102 and ground.

b. The modifications referred to in figures 5-1A, 5-4A, and 5-4B are changes only in the external appearance of the chassis and front panel of the receiver-indicator, as produced by two different manufacturers. All circuits, component values, and layouts are the same in the two equipments.

SECTION VI SUPPLEMENTARY DATA

1. GENERAL.

The equipment operates on the LORAN (Long Range Navigation) principle, a system for finding the position of an airplane by reception of radio signals from transmitting stations of known location. The LORAN system furnishes position data to operators at greater distances from transmitting stations than is possible by other methods of radio navigation.

The overall LORAN system includes: ground installations (transmitters), which provide special radio signal patterns within their service area, an airborne installation (receiver-indicator) which receives and measures the timing of the special radio signals, and charts, tables and tabulations for use in interpreting the timing measurements. The accuracy of the system, and the ease and speed with which readings may be made and interpreted, make the LORAN system particularly useful in air navigation.

Ground installations consist of groups of radio transmitting stations usually located along shore lines, with all stations in a group operating on the same radio frequency. The transmitting frequencies lie between 1700 and 2000 kilocycles for operation of Receiver-Indicator R-65/APN-9. The transmitting stations emit a steady succession of pulses (short, sharp radio frequency signals) which travel outward in all directions at the velocity of light. The transmitting stations operate in pairs; in each pair, station A is the master station and station B, the slave station. The master station A triggers the slave station B by means of a radio link, thereby synchronizing the transmission of the pulses from these two stations.

The service area is dependent on the power and location of the transmitting stations, together with the propagation loss. During daytime, the reception is provided by the ground wave path of propagation, while at night, the area is increased by the addition of less attenuated sky wave signals.

Two systems of LORAN have been developed: Standard LORAN in which the stations of a pair are located sufficiently close to each other to use ground waves exclusively for the radio synchronizing link; and SS LORAN, in which the distance between stations of a pair is so great that Sky wave Synchronization is required. The standard LORAN system has its stations arranged in chains and is especially adapted to cover coastal waters or long, narrow seas. Ground waves provide "fixes" near the stations and are usable over approximately 850 statute miles by day over sea, and approximately two-thirds this distance at night. The ground wave reception area is considerably less over land than over sea. Beyond these ranges, sky waves are

employed at night up to a maximum range of 1600 statute miles over land or sea. The SS LORAN system spaces the stations nearly as far apart as the service range, and its pairs are arranged to surround the service area providing more accurate charting of position at greater distances from the stations than with the standard system. The SS system is used only at night with sky waves and has a maximum service range of 1600 statute miles over land or sea from each station.

The receiver-indicator will operate at any altitude between sea level and 40,000 feet. It receives, amplifies, and detects the LORAN signal pulses, and displays them on the screen of cathode-ray indicator tube which enables the operator to identify the signals from *one pair* of LORAN ground stations according to their r-f channel, pulse repetition rate (PRR), and station rate. The LORAN operator employs the receiver-indicator to measure the indicated time difference between pulses received from *one pair* of transmitting stations. Since the velocity of radio waves is constant, the time required for a signal pulse to travel a given distance is a measure of that particular distance. The operator compares the pulses from one pair of transmitting stations, and can determine the time difference between the pulse from one transmitting station and the synchronized pulse from the other station. This information, together with known and charted data, tells the operator how much farther one pulse has traveled than the other, and indicates the differences of the distances from the two transmitting stations to the airplane. The information thus obtained from the charted data discloses to the operator the position of the airplane somewhere upon a particular hyperbolic curve, which is known as the LORAN line of position. The difference in time between the pulses from a *second pair* of transmitting stations discloses to the operator the position of the airplane somewhere on a *second* hyperbolic curve which crosses the first hyperbolic curve (LORAN line of position). The intersection of the two LORAN lines of position, obtained from the *two pairs* of transmitting stations, indicates the position of the airplane.

The LORAN tables and charts enable the operator to plot the position of the airplane directly from the observed time differences, without calculation and without recourse to communication with the transmitting stations.

Receiver-Indicator R-65/APN-9 may also be employed to navigate an airplane along a plotted course wherever the plotted course coincides with a LORAN line of position. With the LORAN system, this may be accomplished with ease and precision by holding the airplane to a course that will maintain a constant indicated time difference.

2. TUBE COMPLEMENT.

Tube complement for Receiver-Indicator R-65/APN-9 is as follows:

RADIO RECEIVER CIRCUITS

Quantity	JAN Type No.	Function	Reference Symbol
1	JAN-6SK7	R-F amplifier	V-101
1	JAN-6SA7	Oscillator and converter	V-102
1	JAN-6SK7	1st i-f amplifier	V-103
1	JAN-6SK7	2nd i-f amplifier	V-104
1	JAN-6SJ7	3rd i-f amplifier	V-105
1	JAN-6SL7GT	Detector	V-106-B
		Video amplifier	V-106-A

TIMER

1	JAN-6SN7GT	Crystal oscillator	V-107-A
		10-microsecond blocking oscillator	V-107-B
1	JAN-6SN7GT	50-microsecond blocking oscillator	V-108-A
		100-microsecond blocking oscillator	V-108-B
1	JAN-6H6	50-microsecond counter	V-109
1	JAN-6H6	50-microsecond feedback	V-110
1	JAN-6H6	100-microsecond counter	V-111
1	JAN-6H6	100-microsecond feedback	V-112
1	JAN-6SN7GT	500-microsecond blocking oscillator	V-113-A
		1000-microsecond blocking oscillator	V-113-B
1	JAN-6H6	500-microsecond counter	V-114
1	JAN-6H6	1000-microsecond counter	V-115
1	JAN-6SN7GT	5000-microsecond blocking oscillator	V-116-A
		15,000 to 20,000-microsecond blocking oscillator	V-116-B
1	JAN-6H6	5000-microsecond counter	V-117

DELAY AND DEFLECTION CIRCUITS

1	JAN-6SN7GT	Pulse rectifier	V-118-B
		Slow sweep	V-118-A
1	JAN-6SN7GT	E. J. multivibrator	V-119-A
			V-119-B
1	JAN-6SN7GT	Cathode follower	V-120-B
		1st squaring amplifier	V-120-A
1	JAN-6SN7GT	2nd squaring amplifier	V-121-B
		D-C restorer	V-121-A
1	JAN-6N7	Marker mixer	V-122-A
			V-122-B
1	JAN-6SN7GT	Coarse delay multi-vibrator	V-123-A
			V-123-B
1	JAN-6SN7GT	Fine delay multivibrator	V-124-A
			V-124-B
1	JAN-6SN7GT	Clipper	V-125-B
		Differential mixer clipper	V-125-A
1	JAN-6SN7GT	Differential mixer	V-126-A
			V-126-B
1	JAN-6SN7GT	Fast sweep	V-127-A
			V-127-B
1	JAN-6SL7GT	Horizontal amplifier	V-135-A
			V-135-B
1	JAN-6SL7GT	Restorer	V-134

POWER SUPPLY

Quantity	JAN Type No.	Function	Reference Symbol
1	JAN-2X2	High voltage rectifier	V-128
1	JAN-5Y3GT/G	Low voltage rectifier	V-129
1	JAN-6Y6G	Voltage regulator	V-130
1	JAN-6SJ7	D-C amplifier	V-131
1	JAN-OC3/VR105	Voltage control	V-132

INDICATOR

1	JAN-3BP1	Indicator	V-133
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3. ELECTRICAL CHARACTERISTICS.

a. FREQUENCY RANGE.—The frequency range of the radar set is from 1.7 to 2.0 megacycles.

- (1) "R.F. channel"—position 1—1.9-2.0 mc.
- (2) "R.F. channel"—position 2—1.8-1.95 mc.
- (3) "R.F. channel"—position 3—1.8-1.9 mc.
- (4) "R.F. channel"—position 4—1.7-1.85 mc.
- (5) I.F. Frequency—1.1 mc.

b. PRESET FREQUENCIES.—There are four preset frequencies, one adjustable within each of the above bands.

c. RECEIVER SENSITIVITY.—(Output measured across diode load resistor R-119 (100,000 ohms) and corrected for contact potential standard output—4 volts.)

(1) "R.F. Channel" "1," "2," "3" and "4"—7 microvolts.

d. RECEIVER SELECTIVITY.—Overall bandwidth measured 6 db down from maximum response—50 to 75 kilocycles.

e. POWER SUPPLY.

(1) 80 or 115 volts alternating current, 360 to 2460 cycles per second.

(2) 190-volt-ampere, at 115 volts.

(3) Regulated +B voltage—210 volts.

f. DELAY RANGES.

(1) Coarse Delay—"PRR L"—12,000 microseconds.
"PRR H"—8,000 microseconds.

(2) Fine Delay—950 microseconds.

g. TEMPERATURE RANGE.—The receiver-indicator is designed to operate satisfactorily within a temperature range of -55°C (-67°F) to $+50^{\circ}\text{C}$ ($+122^{\circ}\text{F}$).

4. DEFINITIONS.

MASTER STATION.—In a LORAN pair, the master station emits the pulse defining the beginning of the absolute delay between the pair. The next pulse emitted from the other station (slave station) defines the end of the absolute delay.

SLAVE STATION.—In a LORAN pair the synchronization of the slave station is controlled by the other station (master station).

A good rule to follow is to run the first easily visibly pulses to the right side of the traces when the "SWEEP SPEED" control is in position 2. Then turn the "GAIN" up and swing the "AMP. BALANCE" control first one way, then the other, examining each trace individually to see if there is a weak ground wave or first sky wave to the left of the first easily visible pulse. Figure 6-10F is a good example of a weak ground wave that would have been overlooked if the gain were not turned up. (Compare with figure 6-10G.) The examination for weak pulses should not be hurried, as the first sky wave may have faded down into the noise momentarily. The easy course of placing the first easily visible pulse on the extreme left side of the pedestal and switching immediately to the fastest sweep should be avoided. Remember, the pulses should be drifted to the right side of the medium fast sweep first to look for a weak ground wave or first sky wave, then the desired pulses should be aligned approximately and drifted to the left before switching to the next faster sweep to continue the measuring process.

When the gain is turned up, pulses on the lower trace may project through the upper trace, and on the slow sweep the inexperienced operator may mistake these for pulses on the upper trace. In such instances, turning the gain down momentarily will show clearly which signals are actually on each trace.

There are several things which can cause unusual changes in the shape of all signals, including ground waves, and these may cause the inexperienced operator some confusion.

(1) With the double-pulsed stations, there may be a gradual increase or decrease in amplitude of 5 or 10 percent or so and then a sudden jump back to the original value as the two signals from that station on its two recurrence rates "cross over." Also, when a double-pulsed station is blinking on one of its rates, the signals on its other rate may "breathe" slightly in time with the blinking.

(2) When the "GAIN" control is turned up high to observe weak signals, the entire trace will jump around as strong signals on other recurrence rates drift by, and this should not be confused with changes in the amplitude of the signal itself.

(3) Signals that have "spilled over" from another channel will be characterized by a permanent distortion resembling one stage in the progress of a split. (See figure 6-9.) A similar phenomenon occurs if the receiver becomes mistuned, and it is suggested that the maintenance mechanic be requested to mistune temporarily the oscillator coil of one of the channels of the receiver (not to be confused with the timing oscillator in the indicator) so that the effect can be observed first hand.

d. SPACING OF PULSES AS AN AID TO IDENTIFICATION.—If the first pulse in a train is steady, but there is reason to suspect that it may be a sky wave, its relation to following pulses will often help to resolve the doubt quickly. The usual leading-edge spacing pulses, for various distances between transmitter and aircraft, is shown in figure 6-11. The usual spacing

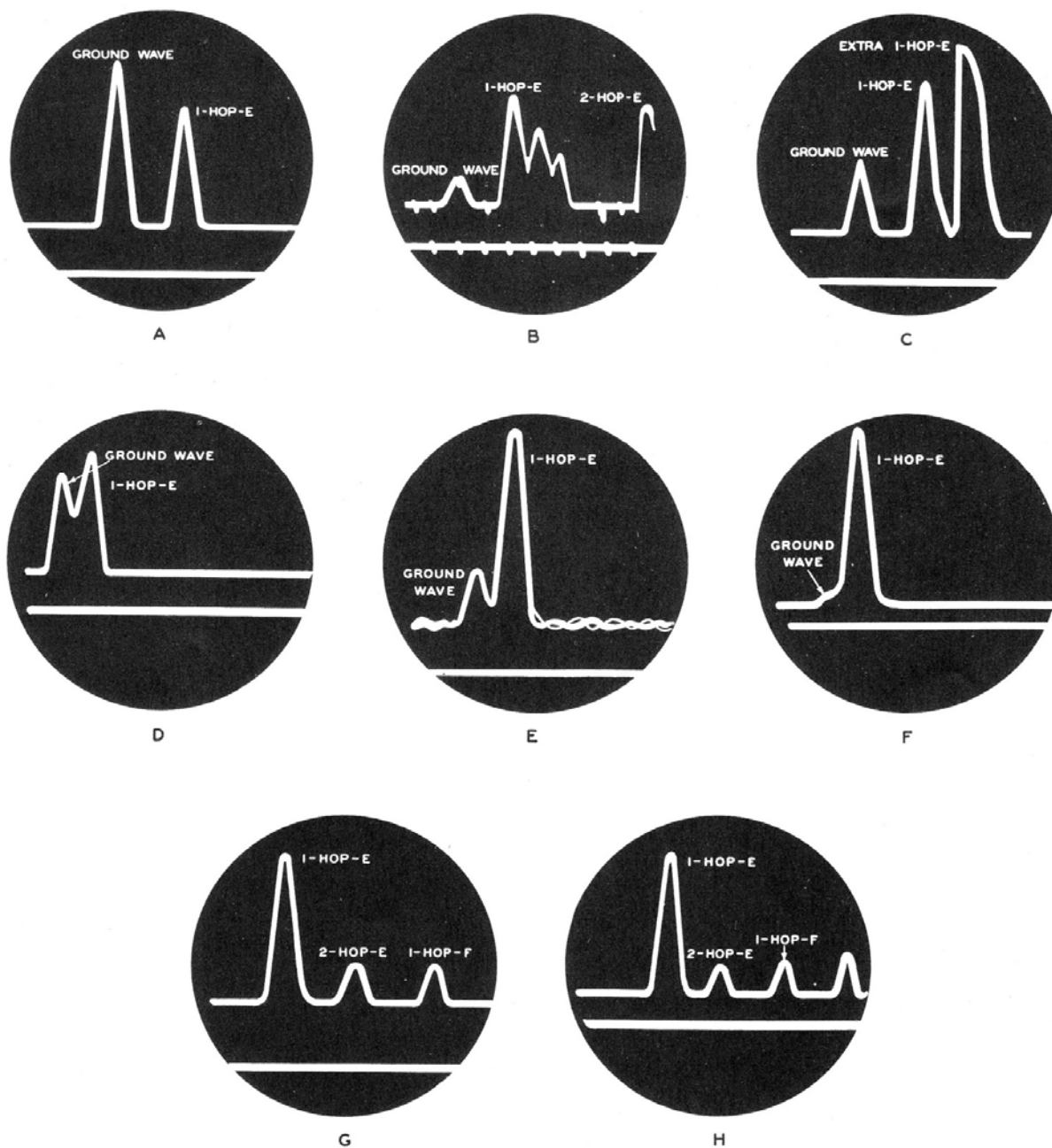
of ground wave to one-hop-E sky wave is nothing more than the sky wave transmission delay curve of figure 6-6 plotted in a slightly different manner to a different scale. Figure 6-11 is so plotted that the usual spacing of ground wave to one-hop-E sky wave to the following sky wave pulses can be read off directly. For example, at 400 miles the spacing between ground wave and one-hop-E sky wave should be about 90 microseconds; the spacing between one-hop-E sky wave and the following sky wave should be roughly 280 microseconds if it is a two-hop-E reflection, or very roughly 550 microseconds if it is a one-hop-E reflection. Note that the spacing is between respective leading edges, and not from the lagging edge of one pulse to the leading edge of the next. Examples of the appearance of pulses at various distances are shown in figure 6-12. It will be realized, of course, that the appearance will vary greatly with conditions, and that the apparent spacing depends somewhat upon the relative amplitudes of the pulses.

Pulse spacings as an aid to identification must be considered only a rough guide, especially by inexperienced operators. There are several complicating factors. Often the two-hop-E reflection is missing, and the pulse following the one-hop-E reflection is the one-hop-F. Occasionally there is an extra one-hop-E reflection immediately following the regular one, or overlapping its lagging (right) side. Again there may be a number of small irregular reflections immediately following the first pulse and it may be very difficult to decide just which is the "second" pulse.

In the middle of the day the spacing between ground wave and one-hop-E sky wave may be somewhat less than at other times. This is shown clearly by comparing figures 6-10A and 6-10C. On rare occasions in the daytime, the first sky wave may actually overlap the right edge of the ground wave at distances of 500 miles or more from a station, as shown in figure 6-12E. These close-spaced daytime sky waves, which are sometimes referred to as "D-layer" reflections are sufficiently rare that they should not cause undue operating difficulties.

During late afternoon and early morning daylight hours particularly, there may be only one sky wave, not a long train of waves. Also, this single sky wave may be unusually steady. Therefore, just because there is only one pulse visible do not jump to the conclusion that it is a ground wave.

If it is desired to determine the spacing of the leading edges of two pulses in a train of pulses more closely than can be done by visual inspection, the following procedure can be used: Assume the two pulses in question are on the top trace: take any one pulse on the bottom trace as a pointer and match it first with one pulse on the top trace and then with the other. In each case read the time difference in the conventional manner. Then take the difference in these two readings, and that is the spacing in microseconds between the two pulses in question, on the top trace. If the two pulses in question are on the bottom trace, the procedure is the same, except use any one pulse on the top trace for the pointer.



Typical ground and sky waves under various conditions. Disregard time markers where shown, as these do not appear on Radio Set AN/APN-9. (a) Distance 310 nautical miles. Early evening. Note usual large spacing between ground and sky waves at this distance. (b) Same distance, at night. Spacing remains the same, one-hop-E sky wave is split. (c) Same distance, at night. Extra one-hop-E wave appears. This condition requires care in identification especially if ground wave is weak. (d) and (e) Distance 770 nautical miles, in daytime. Spacing between ground wave and sky wave is much reduced. Daytime sky waves are occasionally seen at these greater distances. (f) and (g) 770 nautical miles, at night. Ground wave covered by noise. Usual spacing for this distance shown in (g). (h) Distance 1170 nautical miles, at night, showing usual spacing for this distance.

Figure 6-12. Typical Ground and Sky Waves

e. CONDITIONS WHERE THE ONE-HOP-E SKY WAVE MAY BE MISSING.—Sky wave identification depends upon the fact that under nearly all practical conditions, the one-hop-E sky wave will be the first sky wave. There are a few rare situations, however, where this may not be the case.

As has been previously noted, the one-hop-E sky wave becomes weak near the 1,400 mile limit of the charts, and possibly at somewhat shorter distances where the sky wave starts out from the transmitter over land. If the precaution of always turning up the gain and searching and waiting for weak pulses to the left of the easily visible ones is followed, the mistaking of two-hop-E reflection for the one-hop should seldom occur. The spacing between pulses may be of some help in identification; it will be noted that near the 1,400 mile limit the relative spacing of the one-hop-E and two-hop-E reflections is roughly the same as the spacing between ground wave and one-hop-E reflection at about 600 miles. In any event the mistaking of a two-hop-E and two-hop-E reflections is roughly the same as about 50 miles in the line-of-position, and this should be immediately obvious.

When within 250 miles of a station, the E-Layer reflections may be very weak or absent altogether, and the first visible sky waves may be F-Layer reflections several thousand microseconds behind the ground wave. As sky waves are not normally used within this limit, this should cause no inaccuracies. When land intervenes between station and ship, however, recognition of the possibility of missing E-Layer reflections indicates that a careful search should be made several thousand microseconds ahead of the first easily visible sky wave to make sure that a weak but entirely usable ground wave is not being overlooked. A careful preliminary examination should be made on the slow sweep, as the separation may slightly exceed the width of the pedestal.

Under extremely abnormal noise level conditions, it is possible at rare intervals for the two previously mentioned situations to be aggravated, and for E-Layer reflections to be missing considerably within the outer limits of the tables, and also at distances slightly in excess of the 250-mile inner limit. This condition may be artificially produced by a break in the antenna lead-in. The effective antenna length may then be only a few inches, and signal pick-up may be sufficient to allow strong F-Layer reflections to rise above the inherent noise or "grass" generated within the receiver itself, but not sufficient to allow weak E-Layer reflections to be seen. Attempts to use an abnormally short temporary antenna may also cause trouble. If it is suspected that these conditions exist, try disconnecting the antenna at the receiver, and if the "grass" level on the scope does not go down, something is wrong.

10. PULSE MATCHING.

a. MATCHING GROUND WAVES.—When strong ground waves are received from both stations of a pair, the matching process consists of adjusting the two pulses

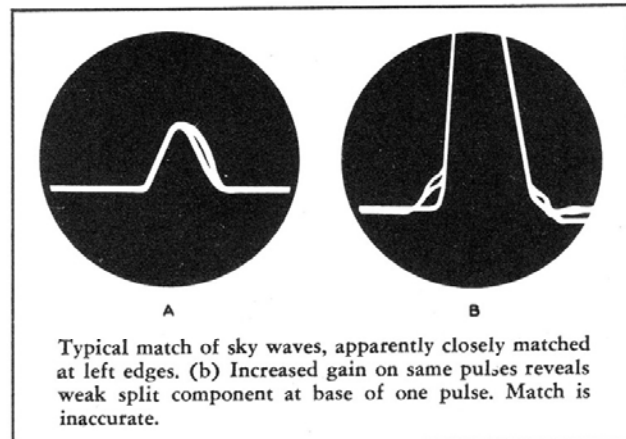


Figure 6-13. Typical Match of Sky Waves

to the same amplitude with the "GAIN" and "AMP. BALANCE" controls and superimposing the left edges of the pulses, beginning at the base and continuing up the left side nearly to the top. Be careful that the gain is not turned up to the point where the tops of the pulses are distorted by overloading of the receiver. If the shapes of the two leading edges are not quite the same, the amplitudes of the two pulses should be made slightly different to allow a better fit of the left edges, but one pulse should be at least three-fourths as high as the other.

When the ground waves are weak and flicker because of noise, take your time and try to get a match between noise crashes or work for an average match. Concentrate on the left edge, and do not worry about a match all the way to the top. The accuracy of a match made under noisy conditions is surprisingly good, much better than would be expected by just looking at the match. The operator should try taking a number of readings in quick succession under such conditions and he will be surprised to find that they will differ by only a few microseconds. Also, accuracy under such conditions will improve a great deal with practice.

b. MATCHING SKY WAVES.—When matching sky waves, it is important to make sure that a split sky wave has not been matched when the leading edge has split down into the noise. If the leading edges of the sky waves do not have the same slope so that the left edges cannot be superimposed, look for splitting immediately. Watch and wait. When what is considered a good match has been obtained, the gain should be turned up as far as noise permits to see if the two leading edges stay together. If they do, it is reasonably certain that there is not a split. If they separate, however, watch carefully for a small hump in the leading edge of one of the pulses. This is indicated in figure 6-13. Figure 6-13A appears to be a good match. However, when the gain is turned up as shown in figure 6-13B a hump in the leading edge becomes apparent. (When the sky wave being matched is preceded by a strong ground wave then the ground wave may pull up the leading edge

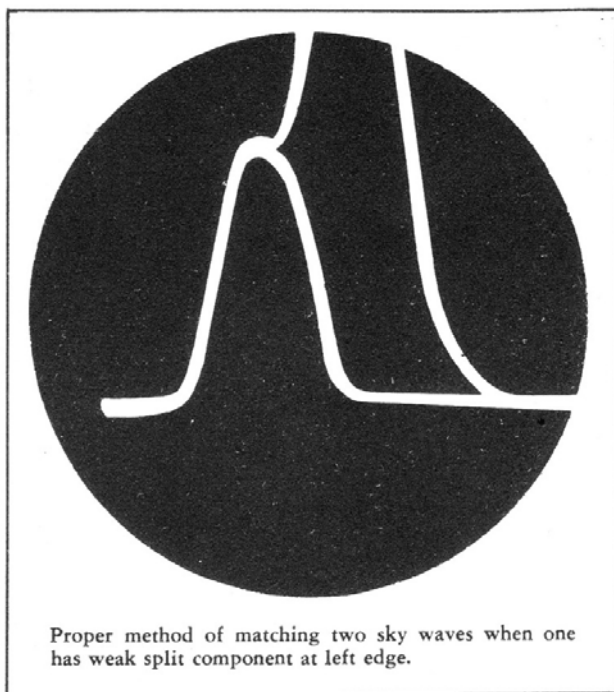


Figure 6-14. Proper Match of Split Sky Waves

of the sky wave when the gain is turned way up, but this should cause no confusion.)

A vast majority of the time sky waves will be sufficiently steady; matching them will be only slightly more difficult than matching ground waves. With skill, however, entirely satisfactory matches may be made even when sky waves are fading or splitting violently.

If the sky waves are fading badly, it will be necessary to manipulate the "FINE" control with one hand and the "GAIN" and "AMP. BALANCE" controls with the other hand. It will sometimes be impossible to keep the pulses aligned under such conditions and it is necessary to work carefully and slowly for as much as several minutes until satisfied that momentarily a good match has been caught. Then stop decisively and take the time-difference reading.

Sometimes a sky wave will stay persistently split with a small leading edge hump for a considerable length of time. The best thing to do is to wait it out, but a fairly accurate reading can be obtained by balancing amplitudes to the small hump and neglecting the rest of the sky wave pulse. (See figure 6-14.) The temptation to turn the gain down so that a small hump on the leading edge cannot be seen, and then match the big steady sky wave remaining should be resisted; observations have consistently shown that the most accurate results are obtained by always matching the first small humps of split sky waves.

c. MISCELLANEOUS SUGGESTIONS.

(1) Under poor conditions more accurate results can be obtained by taking 5 or 10 readings on the same pair of stations in quick succession and then averaging the readings and averaging the times at which they

were taken. This will give one average reading at one average time. When skill in reading the Loran indicator has been acquired, it will not be necessary to go through the entire reading when averaging a number of readings in succession, just read the last digits on the fastest sweep. If there is any doubt, however, go through the entire reading to avoid the possibility of an error.

(2) When matching a very weak signal with a much stronger one, it is sometimes impossible to balance the amplitudes. In this case, the best match is given by setting the weaker signal inside the stronger, allowing from experience for the fact that the leading edge appears further to the left on the pulse with greater amplitude. The "AMP. BALANCE" control should never be set so far to one side that there is appreciable distortion in the shape of the leading edge of one station's pulse.

(3) Under difficult conditions, when signals are very weak, it is sometimes a help to preset the indicator to the expected reading as estimated from the dead reckoning position, applying the sky wave correction if applicable. This trick will be of help in identifying ground or sky waves, as corresponding pulses should be somewhat lined up, if the estimate is close. It is sometimes possible to tell whether the one station is the master or the slave from consideration of double-pulsing stations; if not, then it should be tried first as one and then the other.

(4) Sometimes it is easier to spot a weak signal if it is drifting across the trace than if it is standing still. Therefore, if trouble is encountered in finding a weak signal, try holding the "LEFT-RIGHT" control up or down and looking for a weak pulse drifting to the left or right at about the expected speed.

11. INTERFERENCE AND JAMMING.

The LORAN receiver, like any other kind of radio receiver, is subject to various sorts of interference. This interference may come from transmitters aboard the aircraft, aboard neighboring aircraft, or on the ground, or may be the result of deliberate enemy jamming.

Radio telegraph or "CW" interference will cause the traces to jump up and down in step with the keying. The left end of the traces are particularly susceptible as shown in figure 6-15A. On the fast sweeps the Loran pulses may appear to "spin" on the trace as an axis. If the interference is strong enough, the Loran receiver may "block" and all signals will be reduced in amplitude or disappear altogether when the interference is on.

Radiophone interference will evidence itself in the form of modulation corresponding to the voice superimposed on the traces as shown in figure 6-15B. Radiophone also may cause "spinning" of the pulses or "blocking" of the receiver.

Radar interference takes the form of many uniformly spaced pulses appearing across the screen as

shown in figure 6-15C and 6-15D. They are usually spaced about 500 to 2,000 microseconds apart, but not necessarily so. They usually will be moving across the traces, but if their recurrence rate happens to be right they will stand still on the traces, and look very much like Loran signals, except for the tell tale uniform

spacing. If the radar is scanning, the amplitude of the pulses may vary in accordance with the direction of the radar beam. This radar interference may take place even though the Loran radio frequencies and radar radio frequencies are radically different. While this interference may be very annoying, it is entirely possible to use

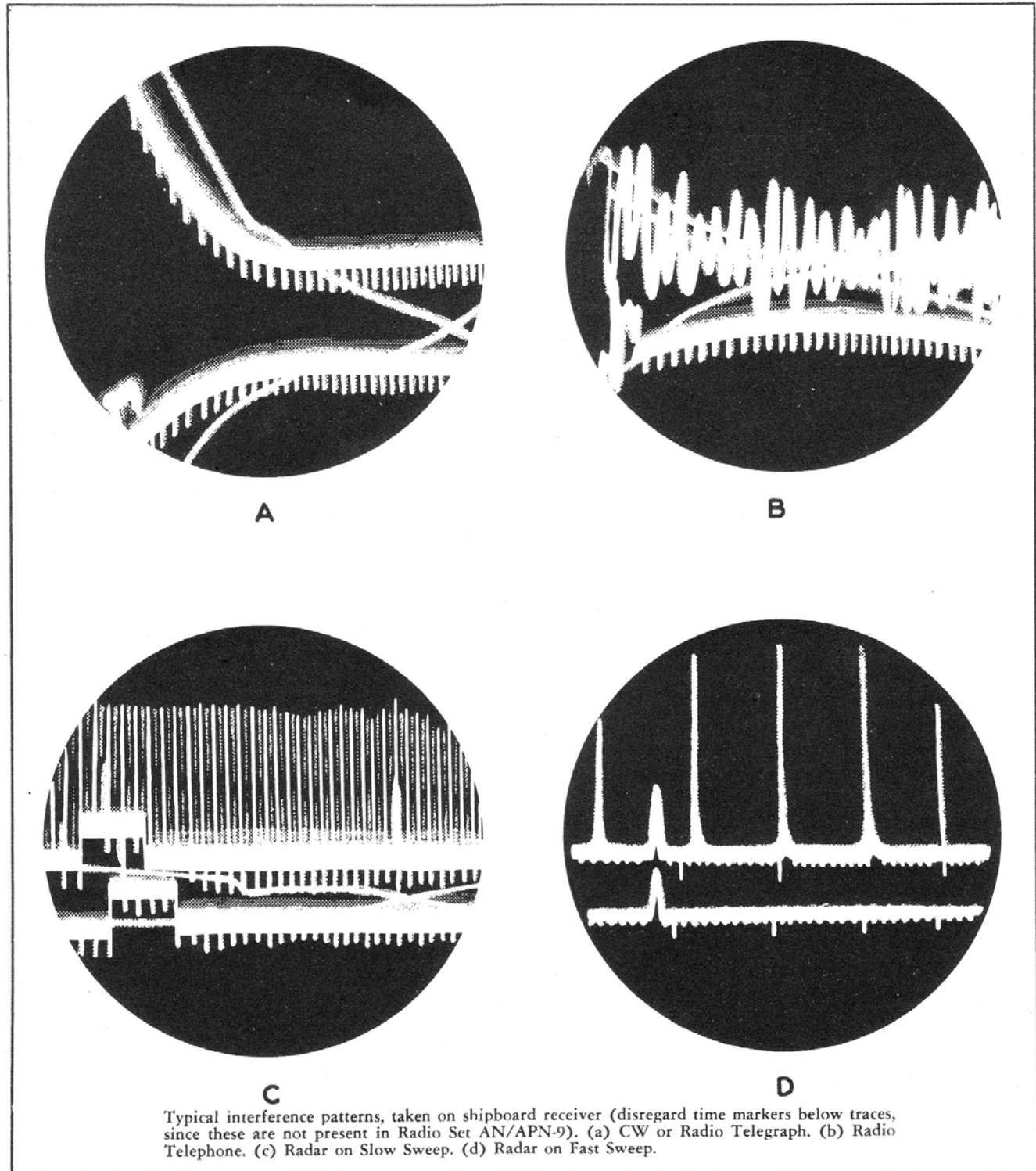


Figure 6-15. Typical Interference Patterns

LORAN signals that are only one-tenth as high as the radar pulses.

Poorly shielded motors or generators will often produce a peaked form of noise that looks very much like radar, except that it is less uniform.

If the Loran indicator is out of adjustment, so that the sweep recurrence rates are not the same as the station recurrence rates, Loran signals may jump around on the traces and appear like noise.

The receiver has a certain amount of inherent noise or "grass." On a very quiet day it may be possible to turn the gain up high enough to see this, or the maintenance mechanic may temporarily disconnect the antenna to demonstrate the effect.

Aircraft sometimes encounter a severe form of interference known as precipitation static, which affects both Loran and radio communications, when flying through snow or rain storms, or in or near certain types of clouds. Precipitation static is often relatively steady, rather than "crashy" and may be sufficiently strong to completely mask Loran signals which ordinarily would appear very strong.

To date no enemy jamming has been experienced with Loran, and the security of Loran should be closely guarded to prevent such jamming. If and when jamming does occur, it may take the form of any of the interference mentioned above, or the form of artificial noise, looking just like natural noise or static, broadcast on the Loran radio frequency channels.

The form of enemy interference most likely to be encountered is the "confusion" signal. It is possible for the enemy to transmit one or more pulses identical in radio frequency and pulse recurrence rates to those transmitted by our own stations. The enemy may achieve

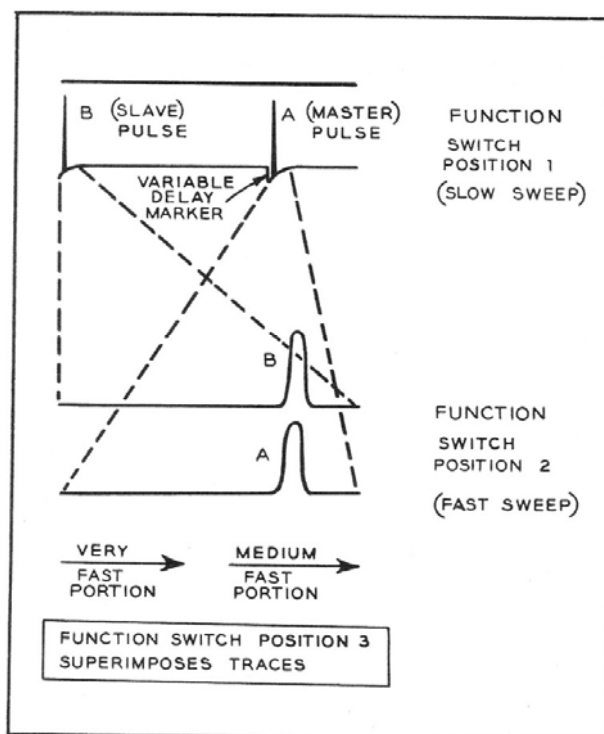
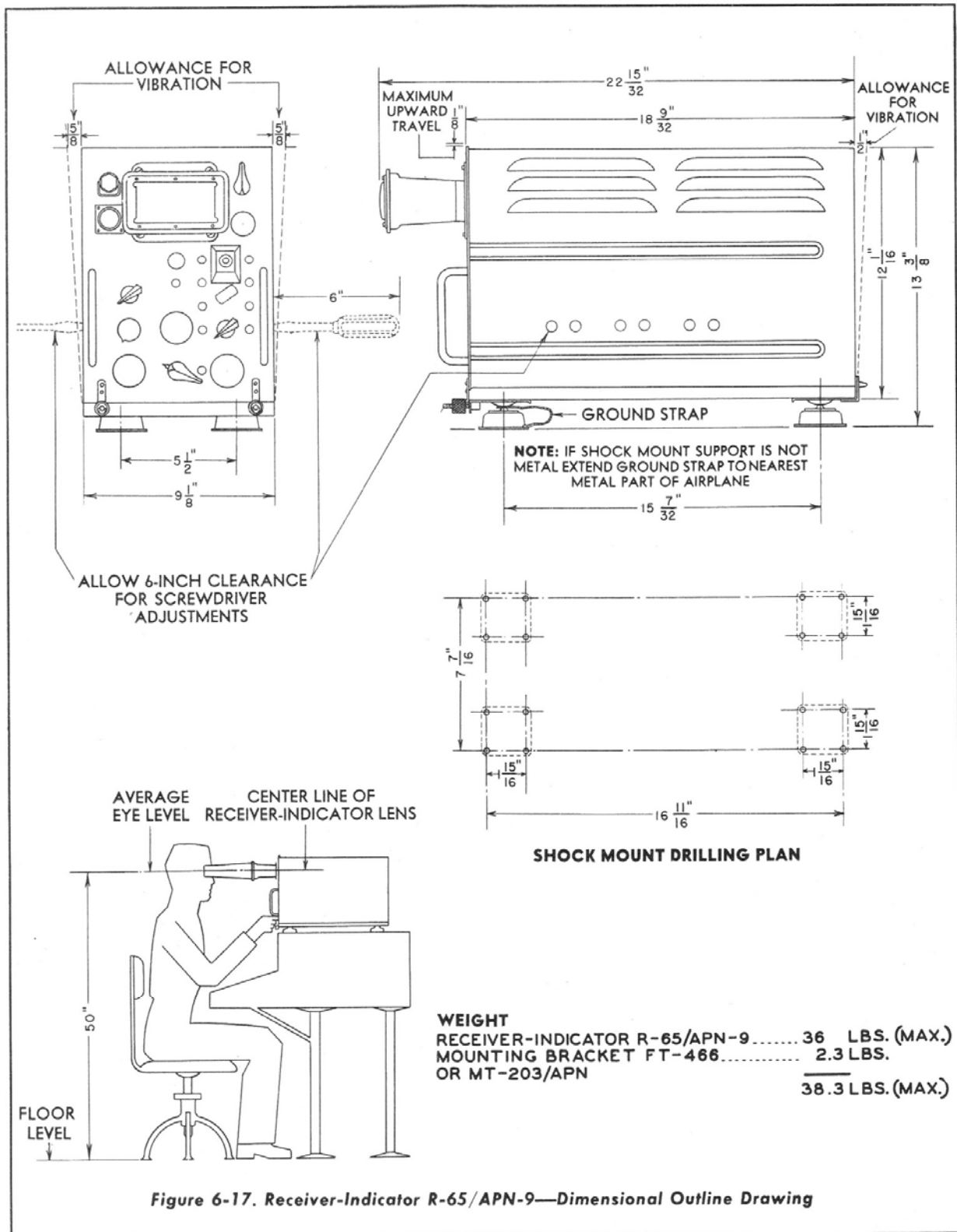


Figure 6-16. Sweep Presentation

synchronization at night, over great distances, by locking on our sky wave. Although there have been no reports to date of such interference, the operator should appreciate its importance. If more than two stationary pulses appear on the slow sweep, unless specific instructions have been given to the contrary, no readings should be attempted on any of the pulses having that basic and specific rate.



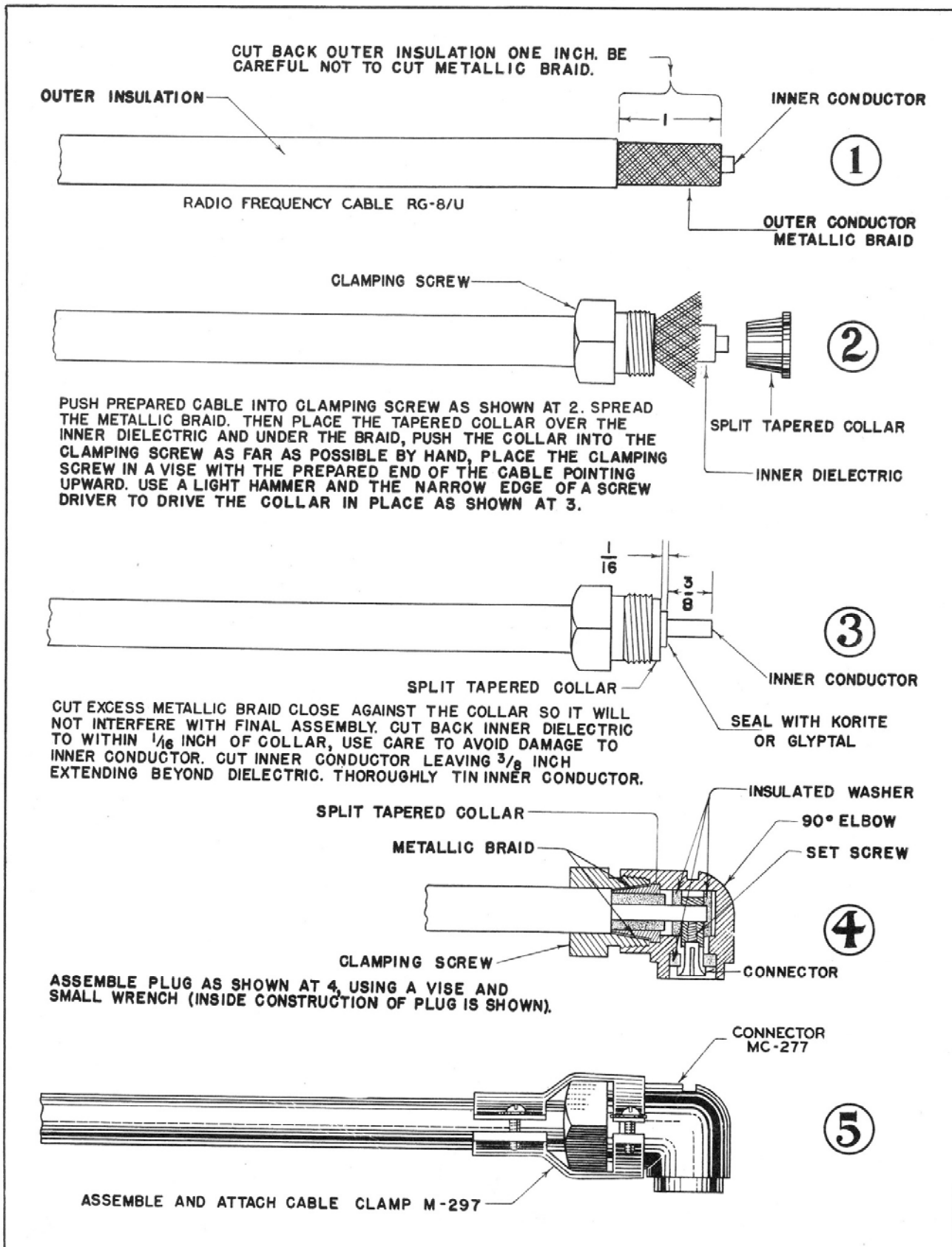


Figure 6-18. Antenna Cable Assembly Drawing

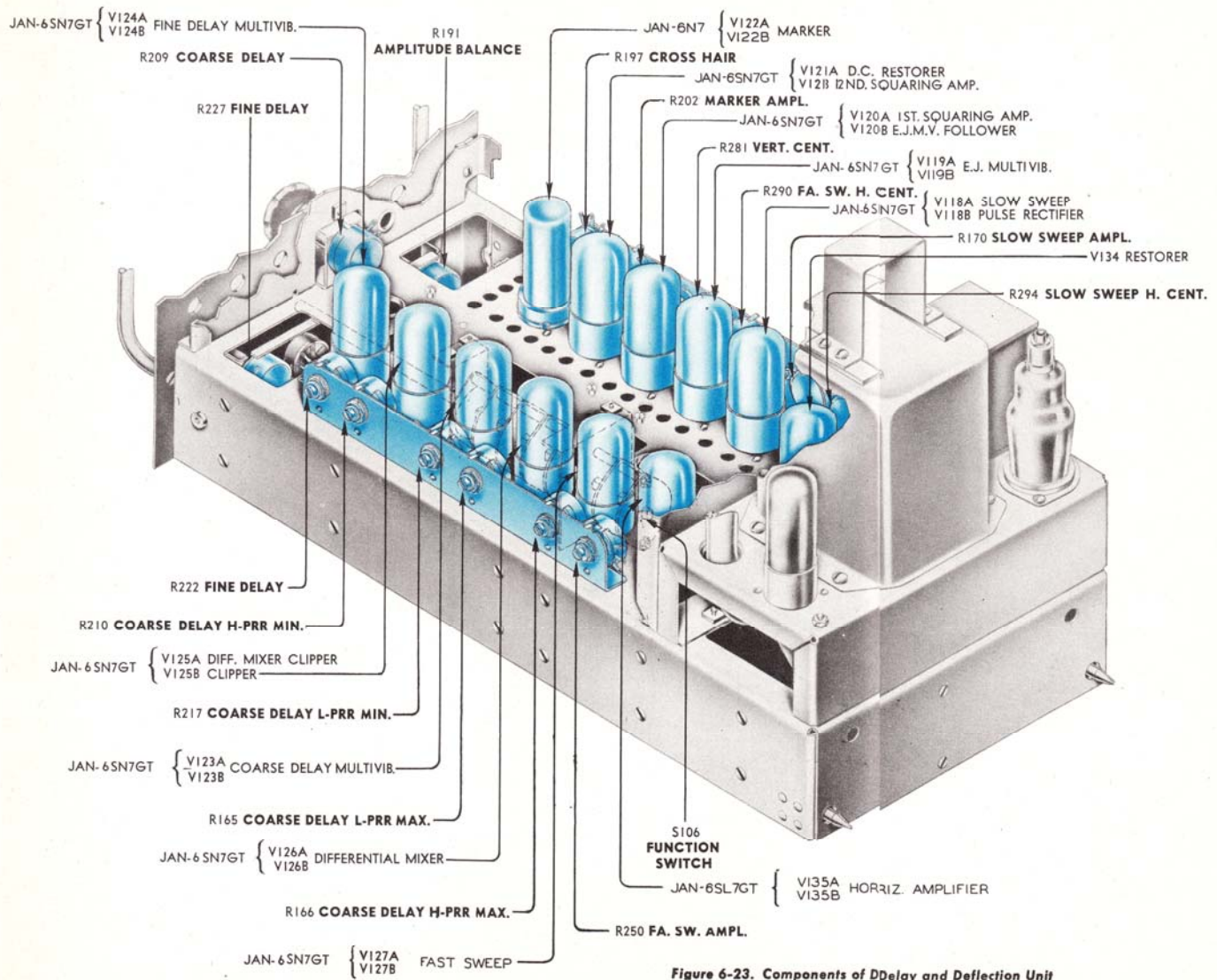


Figure 6-23. Components of DDelay and Deflection Unit

Revised 25 September 1945

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SECTION VII

TABLE OF PARTS

1. CONTENT AND ARRANGEMENT OF TABLE.

a. Listings in the Table of Parts do not constitute a complete breakdown of the equipment but consist of all electrical parts and such operative mechanical parts, with the exception of structural and minor parts such as standard bolts, screws, nuts, etc., that are subject to loss or failure.

b. Parts are grouped by major assemblies. Under each major assembly they are listed (1) alphabetically according to type and (2) numerically under each type.

2. ORDERING SPARE PARTS.

a. GENERAL.—Each Service using the Table of Parts has established certain depots and service groups for the storage and issue of spare parts. The regulations of each Service should be studied to determine the method of requisitioning spare parts and the sources from which they may be obtained. Information in the table pertaining to manufacturers' or contractors' names, types, models, or drawing numbers is not to be interpreted as authorization to field agencies to attempt to purchase identical or comparable spare parts directly from wholesale or retail stores except under emergency conditions as covered by the existing regulations of the Service concerned.

b. U. S. ARMY PERSONNEL.—The Table of Parts is for information *only* and is not to be construed as a list of allowances of maintenance parts or components. Organizations using this equipment will consult applicable AAF Technical Orders of the 00-30 and 00-30A series. Higher maintenance and supply echelons will consult applicable Combat Supply Tables XIIA, XIIB, and XIII.

3. EXPLANATION OF SYMBOLS USED.

a. REFERENCE SYMBOLS (COLUMN ONE).—To identify parts of an equipment referred to in the text, in illustrations, and in the Table of Replaceable Parts, a reference symbol is assigned to each part making up a major assembly of an equipment. Each symbol consists of an alphabetical portion and a numerical portion, separated by a hyphen. (Example C-101.) The alphabetical portion denotes the type of part, classified in accordance with the following list:

<i>Alphabetical Portion of Reference Symbol</i>	<i>Type of Part</i>
A	Structural parts, panels, frames, castings, etc.
C	Capacitors of all types
E	Miscellaneous electrical parts, insulators, knobs, brushes, etc.
F	Fuses
H	Hardware, screws, bolts, studs, pins, snap-slides, tools, etc.

<i>Alphabetical Portion of Reference Symbol</i>	<i>Type of Part</i>
I	Indicating devices (except meters and thermometers), pilot lamps, etc.
J	Jacks and receptacles (stationary)
L	Inductors, radio-frequency, and audio-frequency
O	Mechanical parts, bearings, shafts, couplings, gears, ferrules, flexible shafts, housings, etc.
R	Resistors, fixed and variable (potentiometers, etc.)
S	Switches, interlocks, thermostats
T	Transformers, radio-frequency, audio-frequency and power
V	Vacuum and gaseous discharge tubes
X	Sockets
Y	Mechanical oscillators, crystals, magnetostriction tubes, etc.

The numerical portion of the reference symbol is assigned as follows: Each part in each of the classifications of parts within a major assembly is assigned a number running consecutively for 99 numbers—from 101 to 199 for the first major assembly listed in the table, from 201 to 299 for the second major assembly, etc. If parts in one or more classifications of parts within a major assembly exceed 99, however, the next hundred series, e.g. 301 to 399, is assigned to that major assembly even though only part of the numbers in that series are used. The next major assembly listed then begins with the next series, e.g. 401 to 499. The block of numbers assigned to each major assembly is shown in paragraph 5, this section.

Only one reference symbol is assigned to a part, but suffix letters are sometimes added to distinguish between multiple electrical or mechanical characteristics of a part. Example: C-101A, C-101B, and C-101C identify each part of a triple capacitor C-101; K-101A identifies the coil and K-101B the contacts of a relay K-101.

b. CROSS-HATCH SYMBOL (COLUMN TWO).—Cross-hatch symbols (#) appearing in column two indicate that corresponding parts are not included in any concurrently procured spare parts group.

c. ASTERISK.—The asterisk indicates change appearing in equipments starting with serial number 501.

4. ABBREVIATIONS.

Abbreviations used in the Table of Parts are as follows:

<i>Abbreviation</i>	<i>Definition</i>
amp	amperes
approx	approximately
C	Centigrade
coeff	coefficient
dia	diameter
dim	dimension (s)
DPST	double pole single throw

4. ABBREVIATIONS (Continued).

Abbreviation	Definition
"	inch (es)
ID	inner diameter
I-F	intermediate frequency
JAN	joint Army-Navy
kc	kilocycle (s)
max	maximum
min	minimum
mf	microfarad (s)
mmf	micromicrofarad (s)
mh	millihenry
OD	outer diameter
%	percent
±	plus or minus
pri	primary
R-F	radio frequency
RMA	Radio Manufacturers' Association
sec	secondary
v	volt (s)
vdcw	DC working volts
w	watt (s)

5. INDEX OF MAJOR ASSEMBLIES.

Major Assembly	Numerical Series of Reference Symbols	Page
Receiver-Indicator R-65/APN-9	101-399	7-3 to 7-36

6. DECIMAL EQUIVALENTS OF WIRE SIZES OF AWG AND SWG (BRITISH).

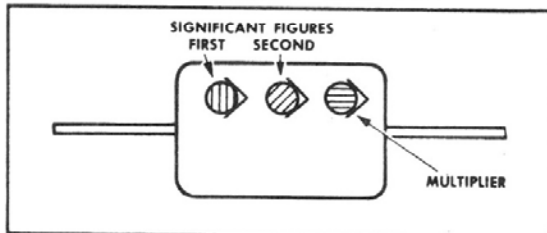
Size AWG	Diameter Inches	Size SWG	Diameter Inches
0000	.46000	0000	.4000
000	.40964	000	.3720
00	.36480	00	.3480
0	.32486	0	.3240
1	.28930	1	.3000

6. DECIMAL EQUIVALENTS OF WIRE SIZES OF AWG AND SWG (BRITISH) (Continued).

Size AWG	Diameter Inches	Size SWG	Diameter Inches
2	.25763	2	.2760
3	.22942	3	.2520
4	.20431	4	.2320
5	.18194	5	.2120
6	.16202	6	.1920
7	.14428	7	.1760
8	.12849	8	.1600
9	.11442	9	.1440
10	.10190	10	.1280
11	.09074	11	.1160
12	.08081	12	.1040
13	.07196	13	.0920
14	.06408	14	.0800
15	.05707	15	.0720
16	.05082	16	.0640
17	.04526	17	.0560
18	.04030	18	.0480
19	.03589	19	.0400
20	.03196	20	.0360
21	.02846	21	.0320
22	.02535	22	.0280
23	.02257	23	.0240
24	.02010	24	.0220
25	.01790	25	.0200
26	.01594	26	.0180
27	.01420	27	.0164
28	.01264	28	.0148
29	.01126	29	.0136
30	.01003	30	.0124
31	.008928	31	.0116
32	.007950	32	.0108
33	.007080	33	.0100
34	.006305	34	.0092
35	.005615	35	.0084
36	.005000	36	.0076
37	.004453	37	.0068
38	.003965	38	.0060
39	.003531	39	.0052
40	.003145	40	.0048

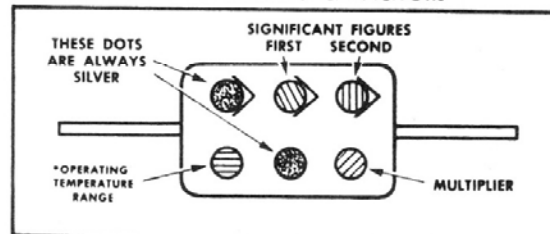
CAPACITOR COLOR CODES

RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



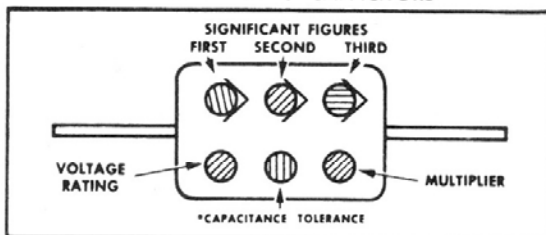
Capacitors marked with this code have a voltage rating of 500 volts.

JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS

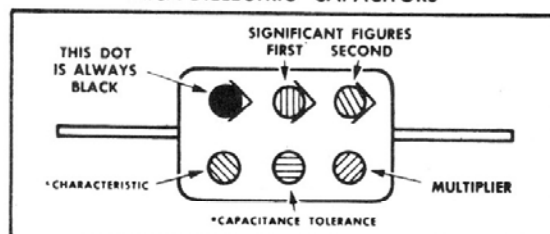


The silver dots serve to identify this marking. For working voltages see JAN type designation code.

RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

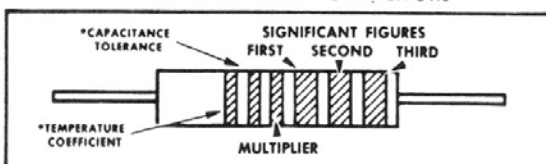


JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



The black dot serves to identify this code. For working voltages see JAN type designation code.

RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



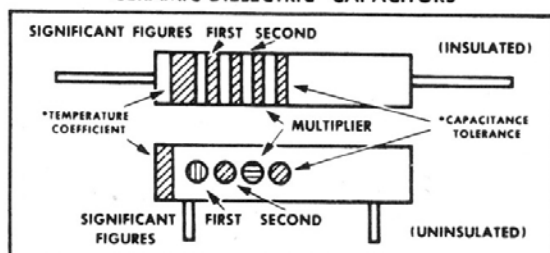
Capacitors marked with this code have a voltage rating of 500 volts.

RMA: Radio Manufacturers Association JAN: Joint Army-Navy

Note: These color codes give all capacitances in micromicrofarads.

*Items marked with an asterisk are of interest primarily to depot and higher echelon repair personnel.

JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

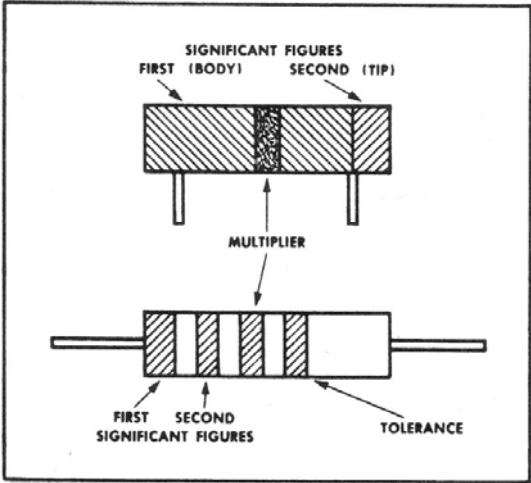


Capacitors marked with this code have a voltage rating of 500 volts. Either the band or dot code may be used.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER			RMA VOLTAGE RATING
		RMA MICA-AND CERAMIC-DIELECTRIC	JAN MICA-AND PAPER-DIELECTRIC	JAN CERAMIC-DIELECTRIC	
BLACK	0	1	1	1	
BROWN	1	10	10	10	100
RED	2	100	100	100	200
ORANGE	3	1,000	1,000	1,000	300
YELLOW	4	10,000			400
GREEN	5	100,000			500
BLUE	6	1,000,000			600
VIOLET	7	10,000,000			700
GRAY	8	100,000,000		0.01	800
WHITE	9	1,000,000,000		0.1	900
GOLD		0.1	0.1		1,000
SILVER		0.01	0.01		2,000
NO COLOR					500

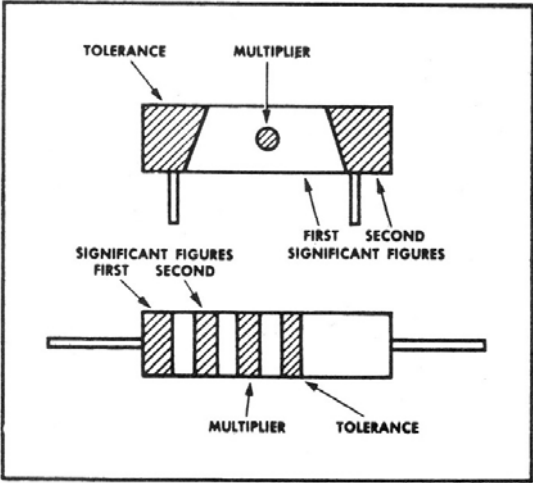
RESISTOR COLOR CODES

RMA COLOR CODE FOR
FIXED COMPOSITION RESISTORS



Insulated fixed composition resistors with axial leads are designated by a natural tan background color. Non-insulated fixed composition resistors with axial leads are designated by a black background color.

JAN COLOR CODE FOR
FIXED COMPOSITION RESISTORS



Resistors with axial leads are insulated. Resistors with radial leads are uninsulated.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1,000	
YELLOW	4	10,000	
GREEN	5	100,000	
BLUE	6	1,000,000	
VIOLET	7	10,000,000*	
GRAY	8	100,000,000*	
WHITE	9	1,000,000,000*	
GOLD		0.1*	5
SILVER		0.01*	10
NO COLOR			20

*JAN ONLY

Example: A 50,000-ohm resistor with a standard tolerance of 20 percent (no color) would be indicated by a green ring (5), a black ring (0), and an orange ring (000)

RMA: Radio Manufacturers Association
JAN: Joint Army-Navy

JOINT ARMY-NAVY TYPE DESIGNATION CODES FOR ELECTRICAL COMPONENTS

INTRODUCTION: Fixed and variable resistors and fixed capacitors manufactured under JAN specifications may be labeled with a *type designation code* instead of a color code or actual electrical value. For resistors and capacitors marked with the JAN type designation code, electrical values and other data can be determined by consulting the following information.

RESISTORS

FIXED, COMPOSITION

RC **10** **AE** **153** **M**
COMPONENT STYLE *CHARACTERISTIC RESISTANCE *TOLERANCE

COMPONENT: RC signifies *fixed, composition resistor*.

STYLE: A two-digit symbol indicates power rating and physical size.

Resistor style	Wattage
RC10, RC15, RC16	¼ WATT
RC20, RC21, RC25	½ WATT
RC30, RC31, RC35, RC38	1 WATT
RC40, RC41, RC45	2 WATTS
RC65	4 WATTS
RC75, RC76	5 WATTS

RESISTANCE: A three-digit symbol indicates the resistance value in ohms. The first two digits give the first two figures of the resistance value; the third digit gives the number of zeros which follow the first two figures.

RESISTORS

VARIABLE, WIRE-WOUND

RA **15** **A** **1** **RH** **103** **A** **K**
COMPONENT STYLE SWITCH *TORQUE *SHAFT RESISTANCE *TAPER *TOLERANCE

COMPONENT: RA signifies *variable, wire-wound resistor*.

STYLE: A two-digit symbol indicates power rating and physical size and shape.

SWITCH: Symbol A indicates no switch. Symbol B indicates a switch turned ON at start of clockwise rotation.

RESISTANCE: A three-digit symbol indicates the resistance value in ohms. The first two digits give the first two figures of the resistance value; the final digit gives the number of zeros which follow the first two figures. The letter R may be substituted to represent a decimal point; but when R is used, the last digit of the group becomes significant.

RHEOSTATS

WIRE-WOUND, POWER-TYPE

RP **35** **2** **FD** **252** **KK**
COMPONENT STYLE OFF POSITION RESISTANCE *SHAFT *TOLERANCE

COMPONENT: RP signifies all *rheostats*.

STYLE: Same as for variable, wire-wound resistors.

OFF POSITION:

Numeral	OFF position
1	None.
2	At end of counterclockwise rotation.
3	At end of clockwise rotation.

RESISTANCE: Same as for variable, wire-wound resistors.

*Items starred are of interest primarily to depot and higher echelon repair personnel.

CAPACITORS

FIXED MICA-DIELECTRIC

CM **20** **B** **511** **K**
 COMPONENT CASE *CHARACTERISTIC CAPACITANCE *TOLERANCE

COMPONENT: CM signifies *fixed, mica-dielectric capacitor*.

CASE: A two-digit symbol identifies a physical case size and shape.

CAPACITANCE: A three-digit symbol indicates the capacitance value in micromicrofarads. The first two digits give the first two figures of the capacitance value; the final digit gives the number of zeros which follow the first two figures. When more than two significant figures are required, additional digits may be used, the last digit always indicating the number of zeros.

**D-C WORKING VOLTAGE FOR
CAPACITANCE RANGE**

Case	Capacitance range	V _{dcw}
CM20	5-510 mmf	500
CM25	5-1,000 mmf	500
CM30	470-3,300 mmf	500
CM35	470-6,200 mmf	500
	6,800-10,000 mmf	500
CM40	3,300-8,200 mmf	500
	9,100-10,000 mmf	300

NOTE: Working voltages for capacitors above CM40 are stamped on the case.

The d-c working voltage of a capacitor can be determined from the above table when the case size and value of capacitance are known.

CAPACITORS

FIXED, MOLDED, PAPER-DIELECTRIC†

CN **36** **A** **302**
 COMPONENT CASE *CHARACTERISTIC CAPACITANCE

COMPONENT: CN signifies *fixed, molded, paper-dielectric capacitor*.

CASE: Same as for fixed, mica-dielectric capacitors.

CAPACITANCE: A three-digit symbol indicates the capacitance value in micromicrofarads. The first two digits give the first two figures of the capacitance value; the third digit gives the number of zeros which follow the first two figures.

**D-C WORKING VOLTAGE FOR
CAPACITANCE RANGE**

Case	Capacitance	V _{dcw}
CN35	3,000 mmf	800
	6,000 mmf	600
	10,000 mmf	400
CN36	3,000 mmf	400
	6,000 mmf	400
	10,000 mmf	300
CN40	3,000 mmf	400
	6,000 mmf	300
	10,000 mmf	300
CN41	3,000 mmf	600
	6,000 mmf	600
	10,000 mmf	400

The d-c working voltage of a capacitor can be determined from the above table when the case size and value of capacitance are known.

CAPACITORS

FIXED, CERAMIC-DIELECTRIC

CC **20** **AH** **100** **G**
 COMPONENT CASE *CHARACTERISTIC CAPACITANCE *TOLERANCE

COMPONENT: CC signifies *fixed, ceramic-dielectric capacitor*.

CASE: Same as for fixed, mica-dielectric capacitors.

CAPACITANCE: Same as for fixed, molded, paper-dielectric capacitors.

NOTE: All fixed, ceramic-dielectric capacitors have a working voltage of 500 volts, d-c.

*Items starred are of interest primarily to depot and higher echelon repair personnel.

†This is not a JAN specification. These capacitors are covered by AWS C75/221.

TABLE OF PARTS

MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9

MODEL: RADIO SET AN/APN-9

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. Standard Type	Cont. or Govt. Dwg. or Spec. No.
101-399 series	2C4180-65	RECEIVER-INDICATOR, R-65/APN-9: complete with tubes; approx. overall dim. 9" x 12 $\frac{1}{8}$ " x 23".			T-256379-501
A-101	2Z3724-43	SCALE: DIAL ASSEMBLY: calibration covers 210° in 7 steps of 30° each; dial marked 0 to 7 inclusive; formed dia. 1 $\frac{7}{8}$ "; complete with hub and set screw.	Station dial scale	1 Dwg. T-256379-501	
A-102	2Z8308-25	SHIELD, light: formed black Buna "S"; durometer reading 60-70; max. overall dim. 5 $\frac{3}{8}$ " x 3 $\frac{5}{8}$ " x 8 $\frac{1}{2}$ ".	Light shield	2	756-1484 P-255558-1
A-103	2Z2626-20	RING, clamp: c.r. steel; approx. overall dim. $\frac{7}{16}$ " x 1" O.D.	Pulse transf. clamping ring	1 Dwg. K-258890-1	K-258890-1
C-102	3D9045V-5	CAPACITOR, variable: ceramic; 7-45 mmf, temp. coeff. -0.0005 $\pm$ 0.0001 mmf/mm $\frac{1}{2}$ °C.; approx. overall dim .905 x .537" x .640".	Channel 3 ant. coil tuning	5 Type 822-BN	K-258319-1
C-103	3D9045V-5	CAPACITOR: Same as C-102.	Channel 2 ant. coil tuning		
C-104	3D9015-34	CAPACITOR, fixed: ceramic, 15 mmf $\pm$ 5%; 500 vdc; temp. coeff. 0.000470 $\pm$ 0.000070 mmf/mm $\frac{1}{2}$ °C.; unisulated; max. overall dim. .460" x .255" dia. over leads, 1 $\frac{1}{2}$ " radial leads.	Channel 1 ant. coil tuning	5	M-95631-1
C-105	3DK9100-121	CAPACITOR, fixed: ceramic; 100 mmf $\pm$ 10%; 500 vdcw; temp. coeff. 0.000750 $\pm$ 0.000110 mmf/mm $\frac{1}{2}$ °C.; unisulated; max. overall dim. .460" x .255" dia. over leads; 1 $\frac{1}{2}$ " radial leads.	R-F amplifier grid coupling	5	M-95631-2
C-106	3D9500-127	CAPACITOR, fixed: ceramic; 500 mmf $\pm$ 20%; 300 vdcw; unisulated; max. overall dim. .390" x .190" dia. over leads; 1 $\frac{1}{4}$ " radial leads.	R-F amplifier grid filter	3	M-95630-12
*C-107	3DA100-112	CAPACITOR: fixed: molded; paper; 100,000 mmf $\pm$ 20% -10°C.; 60vacw; 400 vdcw, wax impregnated; overall dim. 1 $\frac{7}{16}$ " x $\frac{3}{4}$ " x $\frac{3}{8}$ "; 1 $\frac{1}{4}$ " axial leads.	R-F amplifier	S-14MPMW4-1	305-1086
C-108	3D9045V-5	CAPACITOR: Same as C-102.	Channel 3 r-f amplifier plate tuning		
C-109	3D9045V-5	CAPACITOR: Same as C-102.	Channel 2 r-f amplifier plate tuning		
C-110	3D9015-34	CAPACITOR: Same as C-104.	Channel 1 r-f plate tuning		
C-111	3D9045V-5	CAPACITOR: Same as C-102.	Channel 3 converter grid tuning		

MODEL: RADIO SET AN/APN-9 **TABLE OF PARTS—continued** **MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9**

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C-112	3D9045V-5	CAPACITOR: Same as C-102.	Channel 2 converter grid tuning		
C-113	3D9015-34	CAPACITOR: Same as C-104.	Channel 1 converter grid tuning		
C-114	3DA100-294	CAPACITOR: Same as C-107.	Oscillator cathode bypass	4	M-95634-4
C-115	3D9056-9	CAPACITOR, fixed: ceramic; 56 mmf $\pm 5\%$; 500 vdcw; temp. coeff. 0.000750 ± 0.000110 mmf/mm $^{\circ}$ C.; un-insulated; max. overall dim. .390" x .190" dia. over leads; 1 1/4" radial leads.	Oscillator grid coupling	3	M-95630-1
C-116	3D9045V-5	CAPACITOR: Same as C-102.	Channel 3 oscillator tuning		
C-117	3D9045V-5	CAPACITOR: Same as C-102.	Channel 2 oscillator tuning		
C-118	3D9015-34	CAPACITOR: Same as C-104.	Channel 1 oscillator tuning		
C-119	3DA100-294	CAPACITOR: Same as C-107.	I-F amplifier cathode bypass		
C-120	3DA100-294	CAPACITOR: Same as C-107.	Receiver plate filter		
C-121	3DA100-294	CAPACITOR: Same as C-107.	3rd i-f amplifier screen filter		
C-122	3DB155-1	CAPACITOR: fixed, paper, 1 mf $\pm 10\%$; 120 v a-c 400 vdcw, metal enclosed, oil-filled; overall dim. 17/8" x 1 1/32" x 2 3/32", two 7/8" fork terminals.	Receiver plate filter	1 Dwg. P-720555-52	P-720555-52
C-123	3D9150-36	CAPACITOR, fixed: ceramic, 150 mmf $\pm 5\%$; 500 vdcw, temp. coeff. 0.000220 ± 0.000060 mmf/mm $^{\circ}$ C.; un-insulated; max. overall dim. .860" x .225" dia. over leads, 1 1/2" radial leads.	Diode bypass	5	M-95631-3
C-124	3DA3-70	CAPACITOR, fixed: ceramic, 3000 mmf $\pm 20\%$, 300 vdcw, un-insulated, 1 1/4" radial leads, max. overall dim. 1.078" x .275" dia. over leads.	Video amplifier grid coupling		M-95630-13
C-125	3DK9100-121	CAPACITOR: Same as C-105.	Left shift capacitor		
C-126	3D9010-66	CAPACITOR, fixed: ceramic, 10 mmf $\pm 10\%$, 500 vdcw; temp. coeff. 0.000000 ± 0.000060 mmf/mm $^{\circ}$ C.; un-insulated; max. overall dim. .460" x .225" dia. over leads, 1 1/2" radial leads.	Crystal oscillator feed-back	5	M-95631-4

C-223	3DA100-294	CAPACITOR: Same as C-107.	Horiz. ampl. ph. inv. grid coupling		
C-224	3DA100-294	CAPACITOR: Same as C-107.	Horiz. ampl. ph. inv. feed-back		
C-225	3DA100-294	CAPACITOR: Same as C-107.	Horiz. ampl. deflection coupling		
C-226	3DA3-70	CAPACITOR: Same as C-124.	Video ampl. plate coupling		
C-229	3DA50-75	CAPACITOR: Same as C-221.	Slow sweep coupling		
C-230	3D9010-66	CAPACITOR: Same as C-126.	50 m. s. marking		
C-231	3K3015211	CAPACITOR: Same as C-196.	Relay term.—pur. plug filter		
C-233	3D9033-8	CAPACITOR, fixed: ceramic; 33 mmf $\pm 5\%$; 500 vdcw; temp. coeff. 0.000000 ± 0.000060 mmf/mm $^{\circ}$ C.; max. overall dim. .390" x .190" dia. over leads; uninsulated; 1 1/4" radial leads.	500 m. s. marking	3	M-95630-4
C-234	3D9004E7-3	CAPACITOR, fixed: ceramic; 4.7 mmf $\pm 10\%$; 500 vdcw; temp. coeff. 0.000000 ± 0.000060 mmf/mm $^{\circ}$ C.; max. overall dim. .460" x .225" dia. over leads; uninsulated; 1 1/2" radial leads.	Feed-back	5	M-95631-16
C-235	3DKA250-53	CAPACITOR: Same as C-139.	100 m. s. locking osc. bias		
C-236	3DKA250-53	CAPACITOR: Same as C-139.	500 m. s. locking osc. bias		
C-237	3D9012-33	CAPACITOR: Same as C-131.	Station #7 feed-back		
C-238	3D9045V-5	CAPACITOR: Same as C-102.	Channel #4 osc. tuning		
C-239	3D9045V-5	CAPACITOR: Same as C-102.	Channel #4 r-f secondary tuning		
C-240	3D9045V-5	CAPACITOR: Same as C-102.	Channel #4 r-f primary tuning		
C-241	3D9045V-5	CAPACITOR: Same as C-102.	Channel #4 antenna tuning		
C-242	3D9010-66	CAPACITOR: Same as C-126.	Osc. tuning		

RESTRICTED
AN 16-30APN9-3

MODEL: RADIO SET AN/APN-9 **TABLE OF PARTS—continued** **MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9**

Reference Symbol	British Ref. No. Army Stock No. Navy Stock No.	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C-243	3K2051122	CAPACITOR: Same as C-178.	Wave trap tuning		
*C-244	3DA100-294	CAPACITOR, fixed: 100,000 mmf; same as C-107.	Receiver screen supply bypass		
E-101	3Z12531-3.9	BOARD, Terminal: 46 terminals; thick phenolic insulation board complete with resistors, capacitors and necessary hardware and wiring; 9" x 2 1/2" x 3/32".	Terminal board	1 Dwg. M-254206-501	M-254206-501
E-102	3Z12531-3.13	BOARD, Terminal: 29 terminals; thick phenolic insulation board complete with resistors, capacitors and necessary hardware and wiring; 6 3/4" x 2 1/2" x 3/32".	Terminal board	1 Dwg. M-254207-501	M-254207-501
E-103	3Z12531-3.7	BOARD, Terminal: 35 terminals; thick phenolic insulation board complete with resistors, capacitors and necessary hardware and wiring; 7 5/8" x 2 1/2" x 3/32".	Terminal board	1 Dwg. M-254208-501	M-254208-501
E-104	3Z12531-3.10	BOARD, Terminal: 59 terminals; thick phenolic insulation board complete with resistors, capacitors and necessary hardware and wiring; 9 5/8" x 2 1/2" x 3/32".	Terminal board	1 Dwg. M-254209-501	M-254209-501
E-105	3Z12531-3.8	BOARD, Terminal: 12 terminals; thick phenolic insulation board complete with resistors, capacitor and necessary hardware and wiring; 3 3/4" x 2 1/2" x 3/32".	Terminal board	1 Dwg. M-254183-501	M-254183-501
E-106	3Z12531-3.12	BOARD, Terminal: 11 terminals; thick phenolic insulation board complete with capacitors and necessary hardware and wiring; 1 5/8" x 2 3/8" x 3/32".	Terminal board	1 Dwg. M-254183-502	M-254183-502
E-107	3Z12531-3.11	BOARD, Terminal: 9 terminals; thick phenolic insulation board complete with resistors and necessary hardware and wiring; 4" x 2 1/2" x 3/32".	Terminal board	1 Dwg. M-254034-501	M-254034-501
E-108	2Z9405.60	BOARD, Terminal: 5 terminals; thick phenolic insulation; 2 3/4" x 7/16" x 5/16".	Terminal board	16	K-258885-1
E-109	2Z9405.60	BOARD, Terminal: Same as E-108.	Terminal board		
E-110	2Z9405.60	BOARD, Terminal: Same as E-108.	Terminal board		
E-111	2Z9405.60	BOARD, Terminal: Same as E-108.	Terminal board		
E-112	2Z9403.87	BOARD, Terminal: thick phenolic insulation board complete with terminals; 2" x 7/16" x 5/16".	Terminal board	16	K-258885-2
E-113	2Z9404.98	BOARD, Terminal: thick phenolic insulation board complete with terminals; 2 3/8" x 7/16" x 5/16".	Terminal board	16	K-258885-3

E-114	2Z9402.32	BOARD, Terminal: thick laminated phenolic strip complete with terminals; $\frac{3}{4}$ " x $\frac{3}{8}$ " x $\frac{3}{32}$ ".	Terminal board	16	M-253168-8
E-121	2Z5822-97	KNOB, round: black molded compound, approx. overall dim. $\frac{7}{8}$ " x $1\frac{1}{2}$ " dia., complete with insert.	"FINE DELAY" knob	29	P-255541-501
E-122	2Z5822-97	KNOB: Same as E-121.	"COARSE DELAY" knob		
E-123	2Z5822-97	KNOB: Same as E-121.	"AMPLITUDE BALANCE" knob		
E-124	2Z5842.3	KNOB, round: black molded phenolic compound; approx. overall dim. $\frac{5}{8}$ " x $1\frac{1}{16}$ " dia.; complete with insert.	"RECEIVER GAIN" knob	1 Dwg. K-868236-1	K-868236-1
E-125	2Z5822-96	KNOB, round: black molded compound; approx. overall dim. $\frac{5}{8}$ " x $1\frac{1}{16}$ " dia.; complete with insert.	"DRIFT" knob	29	P-255541-502
E-126	2Z5824.25	KNOB: black molded compound; complete with insert; approx. overall dim. $\frac{5}{8}$ " x $1\frac{1}{16}$ " dia.	"STATION" knob	29	P-255541-503
E-127	2Z5821-7	KNOB, bar: black molded phenolic compound; complete with insert; $\frac{5}{8}$ " x $\frac{3}{4}$ " dia. base, $1\frac{1}{4}$ " long.	"PRR" knob	18 Cat. 2300	K-258869-1
E-128	2Z5821-7	KNOB: Same as E-127	"R-F CHANNEL" knob		
E-129	2ZK5748.19	KNOB, bar: black molded phenolic compound; complete with insert and pointer; $1\frac{1}{32}$ " x $\frac{3}{4}$ " dia. base, $1\frac{1}{16}$ " long.	"FUNCTION" knob	18 Cat. 2110-P	K-258870-1
E-130	2Z5761.1	KNOB, lever: black molded phenolic compound; $1\frac{1}{32}$ " x $\frac{3}{4}$ " dia. base, $1\frac{1}{8}$ " long; complete with insert.	"LEFT-RIGHT" knob	18 Cat. 2110	K-258870-2
E-131	3Z1011	CLIP, fuse: 0.020" thick phosphor bronze; formed; approx. overall dim. $1\frac{9}{32}$ " x $1\frac{3}{16}$ " x $\frac{5}{8}$ ".	Fuse clips for spare fuse	19 Cat. 1011	K-99045-1
E-132	3Z3285-3	HOLDER, fuse: approx. overall dim. $2\frac{9}{32}$ " x $\frac{3}{4}$ " dia.	Fuse holder for live fuse	20 Type HCM (less nut & washer) 30 AWS Type NS3W/0108	K-99088-3
E-133	3G1250-16.33	INSULATOR: cylindrical pillar type; steatite; tapped #6-32 x $\frac{3}{8}$ " both ends; overall dim. 1" x $\frac{3}{8}$ " dia.	H-V insulator		M-426765-10
E-134	3G1250-16.33	INSULATOR: Same as E-133.	H-V insulator		
E-135	3G1250-16.33	INSULATOR: Same as E-133.	H-V insulator		
E-136	3G1250-16.33	INSULATOR: Same as E-133.	H-V insulator		
E-138	273600-24	CUSHION: formed; Buna "S" synthetic rubber; durometer reading 45-55; approx. overall dim. $\frac{3}{4}$ " x $\frac{3}{4}$ " dia.	Shock absorber for V-133	2	K-258725-1

* Indicates changes appearing in equipments starting with serial number 501.

RESTRICTED
AN 16-30APN9-3

MODEL: RADIO SET AN/APN-9
TABLE OF PARTS—continued
MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9

Reference Symbol	British Ref. No. Army Stock No. Navy Stock No.	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
E-139	272724-23	CONNECTOR, plate: black molded insulation; beryllium copper contact; complete with $7\frac{1}{8}$ " long lead.	Plate connector	21	K-258886-1
E-140	3G1838-33.4	INSULATION: $\frac{1}{32}$ " thick laminated phenolic insulation; approx. overall dim. $2\frac{1}{16}$ " x $\frac{1}{2}$ ".	Insulation strip	31	K-258875-1
F-101	3Z2602-7	FUSE, cartridge: 2 amp. 250 v; glass body; type 4AG; overall dim. $1\frac{1}{4}$ " x $\frac{9}{32}$ " dia.	Power fuse for 115 v. oper.	19 Cat. 1092	K-850339-8
F-102	321937-37	FUSE, cartridge: 3 amp. 250 v; glass body; type 4AG; Signal Corps Symbol FU-37; overall dim. $1\frac{1}{4}$ " x $\frac{9}{32}$ " dia.	Power fuse for 80 v. oper.	20 Cat. 4AG2	K-850339-11
H-101	6R3875	TOOL, Trimmer adjusting: handle (grey bone fibre tubing) $6\frac{1}{2}$ " long, $\frac{1}{4}$ " dia.; two screw steel screw driver points, $\frac{1}{16}$ " long and $\frac{1}{2}$ " long; and two pins.	Adjusting tool	19 Cat. 1093	K-86183-505
I-101	2Z5881-4	INSTRUMENT LAMP: pilot light; clear; $3\frac{1}{8}$ " x $\frac{1}{8}$ " dia. knurled head; .260" silver plated brass base; $\frac{7}{16}$ "-32 thread; overall dim. $3\frac{3}{16}$ " long x $\frac{3}{16}$ " dia; short sleeve type.	Pilot light	20 Cat. 4AG3	354-1146
I-102	2C4180-65/L1	LENS, magnifying: overall dim. $4.000\frac{1}{2}$ " x $2.000\frac{1}{2}$ " x approx. .550" thick tapered to .100" thick both ends.	Magnifying lens	8 33	K-258696-501
J-102	2Z3021-3 10H-528	CONNECTOR, male contact: single contact, with terminal, approx. overall dim. $1\frac{1}{16}$ " x $\frac{3}{4}$ " dia., Signal Corps No. TM-201, British Type No. 229.	Antenna connector	9 Cat. 46-R5	K-258852-1
J-103	2Z8799-145 10H-392	CONNECTOR, male contact: six contact, male, approx. overall dim. $1.560\frac{1}{2}$ " square x $1\frac{1}{32}$ " x $1.200\frac{1}{2}$ " thread approx. .520", Signal Corps No. SO-145, British Type No. W-199.	Power connector	9 Cat. 46-R2-152	M-254165-1
L-101	2C4180-65/C4	COIL ASSEMBLY: single winding (2 sections) enclosed in shield can; approx. overall dim. $2.148\frac{1}{2}$ " x $1.375\frac{1}{2}$ " x $1.375\frac{1}{2}$ ".	Crystal osc. grid coil	1 Dwg. K-258424-501	K-258424-501
		WINDING: each section 950 turns; 0.005" bare dia. heavy formex magnet wire; universal wound two crosses per turn with reverse gainor; wire traverse $\frac{3}{16}$ " each section; $\frac{1}{16}$ " between sections; includes:	Crystal osc. grid shunt		(M-95631-6)
		CAPACITOR, fixed: ceramic; 12 mmf $\pm 10\%$; 500 vdcw.	Crystal osc. grid coil series		(M-95632-10)
		CAPACITOR, fixed: mica; 510 mmf $\pm 5\%$; 500 vdcw.	Crystal osc. leak		(P-722303-98)
		RESISTOR, fixed: composition; 1 meg. $\pm 10\%$; $\frac{1}{4}$ w.	Crystal osc. plate coil	1 Dwg. P-255549-504	P-255549-504
L-102	2C4180-65/C3	TRANSFORMER: single winding; enclosed in shield can; approx. overall dim. $1.510\frac{1}{2}$ " x $.875\frac{1}{2}$ " dia.			

φL-103		WINDING: 450 turns of 1 strand 0.005" bare dia. heavy formex magnet wire; universal wound 1 cross per turn; wire traverse 1/4"; winding to start 1/2" from end of coil form.	V101 cathode choke	P-1 352-1598	352-1598
Q-101	2Z8304.37	COIL, R-F: choke; single winding; universal wound; unshielded; 46 turns #36 SSE wire; ceramic form, air core; form 3/8" long x 3/16" dia. approx.; two radial wire leads 1 1/2" long; wax impregnated.	Shield for V-133	1 Dwg. P-255595-501	P-255595-501
R-101	3RC10BF105K	SHIELD, Tube: 0.020" thick metal tube shield complete with brackets & shield; approx. overall dim. 9" x 3 1/4" I.D.	R-F grid leak	10 AWS Type RC10BF105K	P-722303-98
R-102	3RC20BF274K	RESISTOR, fixed: composition; 1 megohm ±10%; 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	R-F grid filter	10 Type EB	K-2558897-91
R-103	3RC10AE681K	RESISTOR, fixed: composition; 270,000 ohms ±10%; 1/2 w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	R-F cathode	S-5 A-3	66-1681340
φR-103	3RC20BF221K	RESISTOR, fixed: composition; 680 ohms ±10%, 1/4 watt, insulated, 1 1/2" pigtail leads, max. overall dim. .406" x .170" dia. Replaced by φR103 at serial number 501.	R-F cathode	S-5 A-3	66-1223340
R-104	3RC10BF563J	RESISTOR, fixed: composition; 56,000 ohms ±5%, 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	R-F grid loading	10 34 AWS Type RC10BF563J	P-722303-201
R-105	3RC10BF563J	RESISTOR: Same as R-104.	Osc. grid leak		
R-106	3RC10BF151K	RESISTOR, fixed: composition; 150 ohms ±10%; 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	Converter cathode	10 34 AWS Type RC10BF151K	P-722303-52
R-107	3RC10BF473J	RESISTOR, fixed: composition; 47,000 ohms ±5%; 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	1st i-f loading	10 34 AWS Type RC10BF473J	P-722303-199
R-108	3RC20BF103J	RESISTOR, fixed: composition; 10,000 ohms ±5%; 1/2 w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	Receiver bias	10 Type EB	K-258897-183
R-110	2Z7280-92	RESISTOR, variable: wire wound (nichrome); 5000 ohms ±10%; 5 w; linear; switch (S107) D.P.S.T.; rating 3 amp. 125 v a-c (open in extreme counter-clockwise pos.); approx. overall dim. 1 3/8" x 1 1/4" dia.; 1 1/4" shaft.	Receiver sens. and power control	11 Type WG 252	K-258860-1
R-111	3RC10BF391J	RESISTOR, fixed: composition; 390 ohms ±5%; 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	I-F cathode	10 AWS Type RC10BF391J	P-722303-149
R-112	3RC10BF473J	RESISTOR: Same as R-107.	2nd i-f loading		

*Indicates changes appearing in equipments starting with serial number 501.

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AN 16-30APN9-3

MODEL: RADIO SET AN/APN-9

TABLE OF PARTS—continued

MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
R-113	3RC30BF821K — —	RESISTOR, fixed: composition; 820 ohms $\pm 10\%$; 1 w; insulated; max. overall dim. .718" x .280" dia.; 1.5" pigtail leads.	Receiver + B filter	10 Type GB	K-258898-61
R-114	3RC30BF472K — —	RESISTOR, fixed: composition; 4700 ohms $\pm 10\%$; 1 w; insulated; max. overall dim. .718" x .280" dia.; 1.5" pigtail leads.	R-F, conv., 1st & 2nd i-f screens	10 Type GB	K-258898-70
R-115	3RC30BF472K — —	RESISTOR: Same as R-114.	R-F, conv., 1st & 2nd i-f screens		
R-116	3RC10BF473J — —	RESISTOR: Same as R-107.	3rd i-f loading		
R-117	3RC10BF471J — —	RESISTOR, fixed: composition; 470 ohms $\pm 5\%$; 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	3rd i-f ampl. bias	10 34 AWS Type RC10BF471J	P-722303-151
R-118	3RC30BF683K — —	RESISTOR, fixed: composition; 68,000 ohms $\pm 10\%$; 1 w; insulated; max. overall dim. .718" x .280" dia.; 1.5" pigtail leads.	3rd i-f screen	10 Type GB	K-258898-84
R-119	3RC10BF104J — —	RESISTOR, fixed: composition; 100,000 ohms $\pm 5\%$; 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	Detector plate	10 34 AWS Type RC10BF104J	P-722303-207
R-120	3RC10BF103K — —	RESISTOR, fixed: composition; 10,000 ohms $\pm 10\%$; 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	Detector plate filter	10 34 AWS Type RC10BF103K	P-722303-74
R-121	3RC10BF684K — —	RESISTOR, fixed: composition; 680,000 ohms $\pm 10\%$; 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	Video ampl. grid leak	10 34 AWS Type RC10BF684K	P-722303-96
R-122	3RC20BF184K — —	RESISTOR, fixed: composition; 180,000 ohms $\pm 10\%$; 1/2 w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	Video ampl. plate	10 Type EB	K-258897-89
3-123	3RC10BF333K — —	RESISTOR, fixed: composition; 33,000 ohms $\pm 10\%$; 1/4 w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	Video ampl. plate filter	10 34 AWS Type RC10BF333K	P-722303-80
R-124	3RC30BF472K — —	RESISTOR: Same as R-114.	R-F, conv., 1st & 2nd i-f screens		
R-125	3RC30BF472K — —	RESISTOR: Same as R-114.	R-F, conv., 1st & 2nd i-f screens		
R-126	3RC20BF224J — —	RESISTOR, fixed: composition; 220,000 ohms $\pm 5\%$; 1/2 w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	Left drift load	10 Type EB	K-258897-215

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R-162	3Z6684-1	RESISTOR: Same as R-150.	20,000 microsec. bl. osc. cathode bleeder		
R-163	2Z7270-128	RESISTOR, variable: Same as R-151.	20,000 microsec. bl. osc. adj.		
R-164	3Z6617-5	RESISTOR: Same as R-152.	20,000 microsec. bl. osc. cathode bleeder		
R-165	2Z7270-22	RESISTOR, variable: carbon; 50,000 ohms $\pm 10\%$; 2 w; linear; hot solder dipped terminals; max. overall dim. $\frac{9}{16}$ " x $1\frac{1}{16}$ " dia.; $\frac{5}{16}$ " shaft.	"COARSE DELAY" 25 pps min. delay adj.	A-3 Type "J"	353-5244
R-166	2Z7270-27	RESISTOR, variable: 50,000 ohms; same as R-165.	"COARSE DELAY" 33.3 pps min. delay adj.		
R-167	3RC10BF155K	RESISTOR, fixed: composition; 1.5 megohm $\pm 10\%$; $\frac{1}{4}$ " w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	Pulse rectifier plate	10 34 AWS Type RC10BF155K	P-722303-100
R-168	3RC10BF155K	RESISTOR: Same as R-167.	Pulse rectifier cathode		
R-169	3RC10BF155K	RESISTOR: Same as R-167.	Slow sweep grid leak		
R-170	2Z7273-78	RESISTOR, variable: carbon; 1 megohm $\pm 10\%$; 2 w; linear; hot solder dipped terminals; max. overall dim. $\frac{9}{16}$ " x $1\frac{1}{16}$ " dia.; $\frac{5}{16}$ " shaft.	Slow sweep ampl. adj.	10 Type "J"	M-253729-26
R-171	3RC10BF105K	RESISTOR: Same as R-101.	Slow sweep cathode bleeder		
R-172	3RC20BF124J	RESISTOR, fixed: composition; 120,000 ohms $\pm 5\%$; $\frac{1}{2}$ " w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	Slow sweep cathode bias	10 Type EB	K-258897-209
R-173	3RC20BF393J	RESISTOR, fixed: composition; 39,000 ohms $\pm 5\%$; $\frac{1}{2}$ " w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	E. J. M. V. plate	10 Type EB	K-258897-197
R-174	3RC20BF822J	RESISTOR, fixed: composition; 8200 ohms $\pm 5\%$; $\frac{1}{2}$ " w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	E. J. M. V. cathode bias	10 AWS Type RC20BF822J	P-722318-181
R-175	3RC20BF394J	RESISTOR, fixed: composition; 390,000 ohms $\pm 5\%$; $\frac{1}{4}$ " w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	E. J. M. V. grid coupling	10 Type EB	K-258896-221
R-176	3RC10BF104J	RESISTOR: Same as R-119.	E. J. M. V. grid leak		
R-177	3RC10BF104J	RESISTOR: Same as R-119.	E. J. M. V. pulse coupling		
R-178	3RC10BF104J	RESISTOR: Same as R-119.	E. J. M. V. pulse coupling		

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MODEL: RADIO SET AN/APN-9
TABLE OF PARTS—continued
MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
R-179	3RC10BF104J	RESISTOR: Same as R-119.	E. J. M. V. grid leak		
R-180	3RC20BF394J	RESISTOR: Same as R-175.	E. J. M. V. grid coupling		
R-181	3RC20BF393J	RESISTOR: Same as R-173.	E. J. M. V. plate		
R-182	3RC20BF154J	RESISTOR, fixed: composition; 150,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	E. J. M. V. follower grid coupling	10 Type EB	K-258897-211
R-183	3RC20BF223J	RESISTOR, fixed: composition; 22,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	E. J. M. V. follower cathode	10 Type EB	K-258897-191
R-184	3RC20BF683J	RESISTOR, fixed: composition; 68,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	E. J. M. V. follower cathode	10 Type EB	K-258897-203
R-185	3RC20BF105J	RESISTOR, fixed: composition; 1 megohm $\pm 5\%$; $\frac{1}{4}$ w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	Differential volume control delay	10 Type EB	K-258896-231
R-186	3RC10BF225K	RESISTOR, fixed: composition; 2.2 meg. $\pm 10\%$; $\frac{1}{4}$ w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	1st differential vol. control grid	10 34 AWS Type RC10BF225K	P-722303-102
R-187	3RC10BF105K	RESISTOR: Same as R-101.	1st differential vol. control grid leak		
R-188	3RC20BF104J	RESISTOR, fixed: composition; 100,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	1st differential vol. control plate	10 Type EB	K-258897-207
R-189	3RC10BF225K	RESISTOR: Same as R-186.	2nd differential vol. control grid leak		
R-190	3RC10BF225K	RESISTOR: Same as R-186.	2nd differential vol. control grid		
R-191	2Z7273-63	RESISTOR, variable: carbon; 1 megohm $\pm 10\%$; 2 w; special taper; hot solder dipped terminals; $\frac{1}{4}$ " shaft; max. overall dim. $\frac{9}{16}$ " x $1\frac{1}{16}$ " dia.	"AMPLITUDE BALANCE" control	10 Type "J"	M-253729-28
R-192	3RC10BF473J	RESISTOR: Same as R-107.	2nd differential vol. control plate		
R-193	3RC20BF393J	RESISTOR: Same as R-173.	2nd differential vol. control plate		

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R-194	3RC10BF822J — —	RESISTOR, fixed: composition; 8200 ohms $\pm 5\%$; $\frac{1}{4}$ w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	2nd differential vol. control plate	10 34 AWS Type RC10BF822J	P-722303-181
R-195	3RC10BF105K — —	RESISTOR: Same as R-101.	Differential vol. control filter		
R-196	3RC10BF685K — —	RESISTOR, fixed: composition; 6.8 megohms $\pm 10\%$; $\frac{1}{4}$ w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	Differential vol. control restorer leak	10 34 AWS Type RC10BF685K	P-722303-108
R-197	2Z7273-78 — —	POTENTIOMETER: Same as R-170.	Cross hair adj.		
R-198	3RC10BF563J — —	RESISTOR: Same as R-104.	Vert. deflection filter		
R-199	3RC10BF564K — —	RESISTOR: Same as R-148.	Marker mixer grid		
R-201	3RC10BF564K — —	RESISTOR: Same as R-148.	1st marker mixer grid leak		
R-202	2Z7272-193 — —	POTENTIOMETER: Same as R-131.	Marker amplitude adj.		
R-203	3RC20BF224J — —	RESISTOR: Same as R-126.	Marker mixer cathode bleeder		
R-204	3RC10BF564K — —	RESISTOR: Same as R-148.	2nd marker mixer coupling		
R-205	3RC10BF104J — —	RESISTOR: Same as R-119.	Marker coupling		
R-206	3RC10BF822J — —	RESISTOR: Same as R-194.	Marker mixer plate		
R-208	3RC10BF564K — —	RESISTOR: Same as R-148.	2nd marker mixer grid leak		
R-209	2Z7270-129 — —	RESISTOR, variable: carbon; 10,000 ohms $\pm 10\%$; 2 w; linear; hot solder dipped terminals; max. overall dim. $\frac{9}{16}$ " x $1\frac{1}{16}$ " dia.; $1\frac{3}{16}$ " shaft.	"COARSE DELAY" control 33.3 pps. min. delay adj.	10 Type "J"	M-253729-23
R-210	2Z7270-22 — —	RESISTOR, variable: 50,000 ohms; same as R-165.	"COARSE DELAY" 33.3 pps max. delay adj.		
R-211	3RC10BF104J — —	RESISTOR: Same as R-119.	"COARSE DELAY" m. v. grid		
R-212	3RC20BF104J — —	RESISTOR: Same as R-188.	"COARSE DELAY" m. v. grid bleeder		

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MODEL: RADIO SET AN/APN-9
TABLE OF PARTS—continued
MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
R-213	3RC20BF333J — —	RESISTOR, fixed: composition; 33,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; insulated; max. overall dim. .0468" x .249" dia.; 1.5" pigtail leads.	"COARSE DELAY" m. v. plate	10 Type EB	K-258897-195
R-214	3RC10BF563J — —	RESISTOR: Same as R-104.	"COARSE DELAY" m. v. plate coupling		
R-215	3RC10BF104J — —	RESISTOR: Same as R-119.	"COARSE DELAY" m. v. grid		
R-216	3RC20BF275J — —	RESISTOR, fixed: composition; 2.7 megohms $\pm 5\%$; $\frac{1}{4}$ w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	"COARSE DELAY" m. v. grid leak	10 Type EB	K-258896-241
R-217	2Z7273-78 — —	RESISTOR, variable: 1 megohm; same as R-170.	"COARSE DELAY" 25 pps min. delay adj.		
R-218	3RC20BF103J — —	RESISTOR: Same as R-108.	"COARSE DELAY" m. v. cathode		
R-219	3RC30BF183J — —	RESISTOR, fixed: composition; 18,000 ohms $\pm 5\%$; $\frac{1}{4}$ w; insulated; max. overall dim. .718" x .280" dia.; 1.5" pigtail leads.	"COARSE DELAY" m. v. plate	10 34 Type GB	K-258898-189
R-220	3RC10BF102J — —	RESISTOR, fixed: composition; 1000 ohms $\pm 5\%$; $\frac{1}{4}$ w; insulated; max. overall dim. .406" x .170" dia.; 1.5" pigtail leads.	"COARSE DELAY" m. v. plate filter	10 AWS Type RC10BF102J	P-722303-159
R-221	3RC20BF394J — —	RESISTOR: Same as R-175.	"FINE DELAY" m. v. grid bleeder		
R-222	2Z7270-22 — —	RESISTOR, variable: Same as R-165.	"FINE DELAY" adj.		
R-223	3RC20BF224J — —	RESISTOR: Same as R-126.	"FINE DELAY" m. v. grid		
R-224	3RC20BF683J — —	RESISTOR: Same as R-184.	"FINE DELAY" m. v. grid bleeder		
R-225	3RC20BF333J — —	RESISTOR: Same as R-213.	"FINE DELAY" m. v. plate		
R-226	3RC20BF334J — —	RESISTOR, fixed: composition; 330,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; insulated; max. overall dim. .468" x .249" dia.; 1.5" pigtail leads.	"FINE DELAY" m. v. grid leak	10 Type EB	K-258897-219
R-227	2Z7273-64 — —	RESISTOR, variable: carbon; 600,000 ohms $\pm 10\%$; 2 w; special taper; hot solder dipped terminals; $\frac{1}{4}$ " shaft; max. overall dim. $\frac{9}{16}$ " x $1\frac{1}{16}$ " dia.	"FINE DELAY" control	10 Type "J"	M-253729-27

R-291	3RC20BF154J	RESISTOR: Same as R-182.	Fast sweep horiz. centering bleeder		
R-292	3RC20BF105J	RESISTOR: Same as R-185.	Slow sweep horiz. centering bleeder		
R-293	3RC20BF105J	RESISTOR: Same as R-185.	Slow sweep horiz. centering bleeder		
R-294	2Z7273-78	RESISTOR, variable: Same as R-170.	Horiz. centering control slow sweep		
R-295	3RC20BF274J	RESISTOR: Same as R-282.	Slow sweep horiz. centering bleeder		
R-296	3RC10BF564K	RESISTOR: Same as R-148.	Delay marker coupling		
R-297	3RC10BF225K	RESISTOR: Same as R-186.	Vert. deflection plate leak		
R-298	3RC10BF103K	RESISTOR: Same as R-120.	Sync. coupling		
R-299	3Z5435.1	RESISTOR, fixed: wire wound (nichrome); 3500 ohms $\pm 10\%$; 8 w; coating organic; $\frac{5}{8}$ " radial solder lug terminals; overall dim. 2" x $\frac{9}{16}$ " O.D. and $\frac{3}{8}$ " I.D.	Receiver plate supply series	13	M-253435-14
R-300	3RC10BF225K	RESISTOR: Same as R-186.	Voltage control bleeder		
R-301	3RC10BF473J	RESISTOR: Same as R-107.	Marker mixer bias		
R-302	3RC30BF473K	RESISTOR: Same as R-262.	High voltage filter		
R-303	3RC10BF825K	RESISTOR: Same as R-271.	Horiz. ampl. grid leak		
R-304	3RC10BF105K	RESISTOR: Same as R-101.	Blanking filter		
R-305	3RC30BF821K	RESISTOR: Same as R-113.	Counter plate filter		
*R-306	3RC10AE681K	RESISTOR, fixed: composition, 680 ohms $\pm 10\%$, $\frac{1}{4}$ watt, insulated, $1\frac{1}{2}$ " pigtail leads, max. overall dim. .406" x .170" dia.	V101 screen dropping	S-5 A-3	66-1681340
*R-307	3RC10BF153J	RESISTOR, fixed: 15,000 ohms, same as R-236.	H-V bleeder and divider		
S-101	—	Not used.			
S-102	3Z9825-82.6	SWITCH: 4 position, 4 section, rotary, with shield and bracket, $1\frac{1}{4}$ " shaft, approx. overall dim. $2\frac{5}{16}$ " x $2\frac{7}{16}$ " x $1\frac{13}{16}$ "	R-F channel switch	O-1	452-1254

*Indicates changes appearing in equipments starting with serial number 501.

RESTRICTED
AN 16-30APN9-3

MODEL: RADIO SET AN/APN-9

TABLE OF PARTS—continued

MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
S-103	3Z9825-83.5 — —	SWITCH, rotary: 3 position; single section; $1\frac{5}{16}$ " shaft; approx. overall dim. $4\frac{1}{4}$ " x $1\frac{3}{4}$ " x $1\frac{7}{8}$ ".	"LEFT-RIGHT" switch	23 35	M-253999-1
S-104	3Z9825-83.4 — —	SWITCH, rotary: 8 position; single section; 2" shaft; approx. overall dim. $4\frac{1}{4}$ " x $1\frac{3}{4}$ " x $1\frac{7}{8}$ ".	"STATION" switch	23 35	M-253998-1
S-105	3Z9825-82.5 — —	SWITCH, rotary: 2 position; single section; 2" shaft; approx. overall dim. $\frac{1}{2}$ " x $1\frac{7}{32}$ " x $1\frac{13}{32}$ ".	"PRR" switch	23 35	K-258841-1
S-106	3Z9825-83.3 — —	SWITCH, rotary: 6 position; 6 section; $4\frac{1}{16}$ " shaft; approx. overall dim. $4\frac{5}{16}$ " x $2\frac{1}{2}$ ".	"FUNCTION" switch	23 35	M-253997-1
S-107	NSNR — —	SWITCH, rotary: d.p.s.t.; rating 3 amp., 125 v a-c; open in extreme counterclockwise position; part of R-110.	Switch for R-110		Built into K-258860-1 (Not replaceable)
T-102	2Z9642-45 — —	COIL, radio R-F; antenna; wound in two parts on common form; Winding part 1: 125 turns of 1 strand 0.004" bare dia. double silk covered enameled magnet wire; universal wound 4 crosses per turn; wire traverse $\frac{1}{16}$ "; winding to start $1\frac{1}{32}$ " from end of coil form; Winding part 2: 4 sections; each section 43 turns of 1 strand 0.005" bare dia. single silk covered enameled copper wire; universal wound 4 crosses per turn; wire traverse $\frac{1}{16}$ " each section; $\frac{1}{32}$ " between sections; winding to start $1\frac{1}{16}$ " from same end of coil form as part 1; enclosed in shield can; approx. overall dim. 1.510 " x $.875$ " dia.	Ant. transformer	1 Dwg. P-255549-505	P-255549-505
T-103	2C4180-65/C2 — —	TRANSFORMER; single winding; Winding: 79 turns of 1 strand 0.005" bare dia. enameled round copper magnet wire; right hand wound at 110 turns per inch; winding to start $\frac{3}{16}$ " from end of coil form; enclosed in shield can; approx. overall dim. 1.510 " x $.875$ " dia.	Wave trap	1 Dwg. P-255549-506	P-255549-506
T-104	2C4180-65/C5 — —	COIL, radio, R-F; R-F transformer; wound in 2 parts on common form; Winding part 1: 3 sections; each section 37 turns of 1 strand 0.005" bare dia. single silk covered enameled copper wire; universal wound 4 crosses per turn; wire traverse $\frac{1}{16}$ " each section; $\frac{1}{32}$ " between sections; winding to start $\frac{5}{16}$ " from end of coil form; Winding part 2: same as part 1 except winding to start $\frac{29}{64}$ " from start of part 1; enclosed in shield can; approx. overall dim. 1.510 " x $.875$ " dia.; includes two.	R-F transformer (1800-2000 kc)	1 Dwg. P-255549-502	P-255549-502
		CAPACITOR, fixed; ceramic; 33 mmf $\pm 5\%$; 500 vdcw.	R-F transformer tuning (1.8-2.0 mc)		(M-95630-4)

RESTRICTED

T-121	2Z9619-61 — —	TRANSFORMER, power: fully enclosed steel case; 3" long x 3 5/8" wide x 4 3/16" high; 16 terminals on top of case, primary winding 115V, 360-2640 cycles, tapped at 80V; secondary #1 2 windings tied together, 2.5V filament, 1.75 amps, tapped 1300V between 13, 14 and ground; 400V between 15 and 8 and 16; #2 winding 5.0V, 2.0 amps; #3 winding 6.58V +220V d-c above ground, 1.25 amps; #4 winding 6.9V, 13.3 amps; #5 winding 6.55V — 1600V to ground, 0.9 amps; mounting flange on two sides of case .187" diameter mounting holes 3 13/16" x 2.375" centers. (W. 33-042-sc-2543, W. 33-106-sc-230).	Power transformer	M-3 HI-442	352-7295
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RESTRICTED
AN 16-30APN9-3

MODEL: RADIO SET AN/APN-9
TABLE OF PARTS—continued
MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Design or Standard Type	Cont. or Govt. Dwg. or Spec. No.
V-101	2J6SK7 JAN-()-6SK7	TUBE, electron: triple-grid super-control amplifier; metal; small wafer octal 8-pin base; heater current 0.3 amp. at 6.3 a-c or d-c.	R-F amplifier	Type JAN-6SK7 ^{1a}	
V-102	2J6SA7 JAN-()-6SA7	TUBE, electron: pentagrid converter; metal; small wafer octal 8-pin base; heater current 0.3 amp. at 6.3 v a-c or d-c.	Converter	Type JAN-6SA7 ^{1a}	
V-103	2J6SK7 JAN-()-6SK7	TUBE, electron: Same as V-101.	1st i-f amplifier		
V-104	2J6SK7 JAN-()-6SK7	TUBE, electron: Same as V-101.	2nd i-f amplifier		
V-105	2J6SJ7 JAN-()-6SJ7	TUBE, electron: triple-grid detector amplifier; metal; small wafer octal 8-pin base; heater current 0.3 amp. at 6.3 v a-c or d-c.	3rd i-f amplifier	Type JAN-6SJ7 ^{1a}	
V-106	2J6SL7GT JAN-()-6SL7GT	TUBE, electron: twin-triode amplifier; glass; intermediate shell octal 8-pin base; heater current 0.3 amp. at 6.3 v a-c or d-c.	Detector-video amplifier	Type JAN-6SL7GT ^{1a}	
V-107	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: twin-triode amplifier; glass; intermediate shell octal 8-pin base; heater current 0. amp. at 6.3 v a-c or d-c.	Crystal oscillator 10 microsec. bl. osc.	Type JAN-6SN7GT ^{1a}	
V-108	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	50 microsec. bl. osc. 100 microsec. bl. osc.		
V-109	2J6H6 JAN-()-6H6	TUBE, electron: twin diode; metal; small wafer octal 7-pin base; heater current 0.3 amp. at 6.3 v a-c or d-c.	50 microsec. counter	Type JAN-6H6 ^{1a}	
V-110	2J6H6 JAN-()-6H6	TUBE, electron: Same as V-109.	50 microsec. feed-back		
V-111	2J6H6 JAN-()-6H6	TUBE, electron: Same as V-109.	100 microsec. counter		
V-112	2J6H6 JAN-()-6H6	TUBE, electron: Same as V-109.	100 microsec. feed-back		
V-113	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	500 microsec. bl. osc. 1000 microsec. bl. osc.		
V-114	2J6H6 JAN-()-6H6	TUBE, electron: Same as V-109.	500 microsec. counter		

V-115	2J6H6 JAN-()-6H6	TUBE, electron: Same as V-109.	1000 microsec. counter	
V-116	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	5000 microsec. bl. osc.—15,000- 20,000 microsec. bl. osc.	
V-117	2J6H6 JAN-()-6H6	TUBE, electron: Same as V-109.	5000 microsec. counter	
V-118	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	Pulse rectifier slow sweep	
V-119	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	Eccles-Jordan multivibrator	
V-120	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	E. J. M. V. follower 1st diff. vol. control	
V-121	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	2nd diff. vol. control—diff. vol. control restorer	
V-122	2J6N7 JAN-()-6N7	TUBE, electron: class B twin amplifier; metal; small wafer octal 8-pin base; heater current 0.8 amp. at 6.3 v a-c or d-c.	Marker mixer	1a Type JAN-6N7
V-123	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	"COARSE DELAY" multivibrator	
V-124	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	"FINE DELAY" multivibrator	
V-125	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	Clipper	
V-126	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	Differential mixer	
V-127	2J6SN7GT JAN-()-6SN7GT	TUBE, electron: Same as V-107.	Fast sweep	
V-128	2J2X2 JAN-()-2X2	TUBE, electron: half-wave high-vacuum rectifier; glass; small 4-pin base; heater current 1.75 amp. at 2.5 v a-c.	H-V rectifier	354-1316
V-129	2J5Y3GT/G JAN-()- 5Y3GT/G	TUBE, electron: full-wave high-vacuum rectifier; glass; intermediate shell octal 5-pin base; filament current 2 amp. at 5 v a-c.	L-V rectifier	1a Type JAN-5Y3GT/G
V-130	2J6Y6G JAN-()-6Y6G	TUBE, electron: beampower amplifier; glass; medium shell octal 7-pin base; heater current 1.25 amp. at 6.3 v a-c or d-c.	Voltage regulator	1a Type JAN16Y6G
V-131	2J6SJ7 JAN-()-6SJ7	TUBE, electron: Same as V-105.	D-C amplifier	
V-132	2JOC3/VR105 JAN-()- OC3/VR105	TUBE, electron: voltage regulator; glow discharge; cold cathode; glass; small shell octal 6-pin base; operating current 5-30 ma at 105 d-c.	Voltage control	1a Type JAN- OC3/VR105
V-133	2J3BP1 JAN-()-3BP1	TUBE, electron: high-vacuum cathode ray; green fluor- escence; medium shell diheptal 12-pin base; heater current 0.6 amp. at 6.3 v a-c or d-c.	Indicator	1a Type JAN-3BP1
V-134	2J6SL7GT JAN-()-6SL7GT	TUBE, electron: Same as V-106.	Restorer	

MODEL: RADIO SET AN/APN-9 **TABLE OF PARTS—continued** **MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9**

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Design or Standard Type	Cont. or Govt. Dwg. or Spec. No.
V-135	2J6SL7CT JAN: ()-6SL7CT	TUBE, electron: Same as V-106.	Horiz. amplifier		
X-101	2Z8678.131	SOCKET, Tube: octal, 8 prong; mica filled phenolic compound body; two elastic stop nuts; approx. over-all dim. 1.516" x 1.1932".	Socket for V-101	1 Dwg. K-258791-501	K-258791-501
X-102	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-102		
X-103	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-103		
X-104	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-104		
X-105	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-105		
X-106	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-106		
X-107	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-107		
X-108	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-108		
X-109	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-109		
X-110	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-110		
X-111	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-111		
X-112	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-112		
X-113	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-113		
X-114	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-114		
X-115	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-115		

X-116	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-116		
X-117	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-117		
X-118	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-118		
X-119	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-119		
X-120	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-120		
X-121	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-121		
X-122	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-122		
X-123	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-123		
X-124	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-124		
X-125	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-125		
X-126	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-126		
X-127	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-127		
X-128	2Z8674.104	SOCKET, Tube: high voltage; 4 prong; mica filled bakelite; approx. overall dim. $1\frac{5}{8}$ " x $1\frac{3}{4}$ " x $2\frac{1}{4}$ ".	Socket for V-128	⁹ Cat. 77A-4	K-252406-2
X-129	2Z8678.135	SOCKET, Tube: octal; 8 prong; mica filled phenolic compound body; two elastic stop nuts; approx. overall dim. $1\frac{3}{16}$ " x $1\frac{3}{16}$ " x $1\frac{15}{16}$ ".	Socket for V-129	¹ Dwg. K-258791-502	K-258791-502
X-130	2Z8678.135	SOCKET, Tube: Same as X-129.	Socket for V-130		
X-131	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-131		
X-132	2Z8678.131	SOCKET, Tube: Same as X-101.	Socket for V-132		
X-133	3E3157-27	SOCKET, Tube: 14-contact; bakelite; overall dimen. 2.219" dia. x $1\frac{1}{8}$ " long, wax impregnated.	Socket for V-133	C-1 T-9453Y1	257-6147
		SOCKET ASSEMBLY: contains one bakelite socket, 14 contacts, overall dimensions 2.219" diameter x $1\frac{1}{8}$ " long with 10 conductor type cable 15" long.	Socket and cable for V133	H-2	457-1656

MODEL: RADIO SET AN/APN-9 **TABLE OF PARTS—continued** **MAJOR ASSEMBLY: RECEIVER-INDICATOR R-65/APN-9**

Reference Symbol	Army Stock No. Navy Stock No. British Ref. No.	Name of Part and Description	Function	Mfr. and Design or Standard Type	Cont. or Govt. Dwg. or Spec. No.
X-134	2Z8678-131	SOCKET, Tube: Same as X-101.	Socket for V-134		
X-135	2Z8678-131	SOCKET, Tube: Same as X-101.	Socket for V-135		
X-136	2ZK8761-15	SOCKET, crystal: 1/8" thick laminated phenolic; 3 beryllium copper terminals; approx. overall dim. 2 7/32" x 1 3/8".	Socket for Y-101	16 Type EXP. 7034	K-871261-2
X-137	2Z5882-31	LAMPHOLDER: brass bushing tapped 7/16-32" x 1/8" complete with brass sleeve; insulation and terminal; approx. overall dim. .312" x 7/8" dia.	Socket for I-101	1 Dwg. K-258854-501	K-258854-501
Y-101	2X104-100	CRYSTAL: frequency 100 kc.; approx. overall dim. 2 1/8" x 1 13/32" x 1 1/16".	100 kc. osc.	1 Type VC-5-KL	M-254141-1
O-102	2Z2639-17	CLAMP, cable: neoprene covered aluminum; approx. overall dia. 1 1/16" x 1 1/16" wide .025" thick.	3BP1 cable clamp	36 Cat. 3044-4	K-877148-4
O-103	2Z2639-16	CLAMP, cable: neoprene covered aluminum; approx. overall dia. 3/16" x 1 1/16" wide, .025" thick.	3BP1 cable clamp	36 Cat. 3044-3	K-877148-3
*	*	CLAMP, cable: cold rolled steel; .050" thick.	Cable clamp	1 Dwg. K-17301-4	K-17301-4
*	*	CLAMP, cable: cold rolled steel; .050" thick.	Cable clamp	1 Dwg. K-17301-9	K-17301-9
*	*	HOLDER, Tube: annealed spring steel; .015" thick.	6Y6G tube holder	16	K-94324-1
*	*	BRACKET, Power Transformer: cold rolled steel; 2 1/16" high, .062" thick.	Power transf. bracket	1 Dwg. K-258839-1	K-258839-1
*	*	PLATE: brass; 1.562" x 3/16" x .0907" thick.	"FUNCTION" switch locating plate	1 Dwg. K-258793-3	K-258793-3
*	*	BRACKET, capacitor: cold rolled steel; 2 1/32" high, 1 3/32" thick.	Capacitor bracket	1 Dwg. K-69788-1	K-69788-1
*	*	BRACKET, capacitor: cold rolled steel; 1.281" high, .025" thick.	Capacitor bracket	1 Dwg. K-252559-1	K-252559-1
*	*	CLAMP, socket: fabricated; two brass straps; phosphor bronze brace and necessary hardware.	3BP1 socket clamp	1 Dwg. M-253615-502	M-253615-502
*	*	BRACKET: aluminum; .064" thick.	Bracket	1 Dwg. K-258796-3	K-258796-3

*Parts indicated by an asterisk in column 2 are not available as spare parts and are listed for reference purposes only.

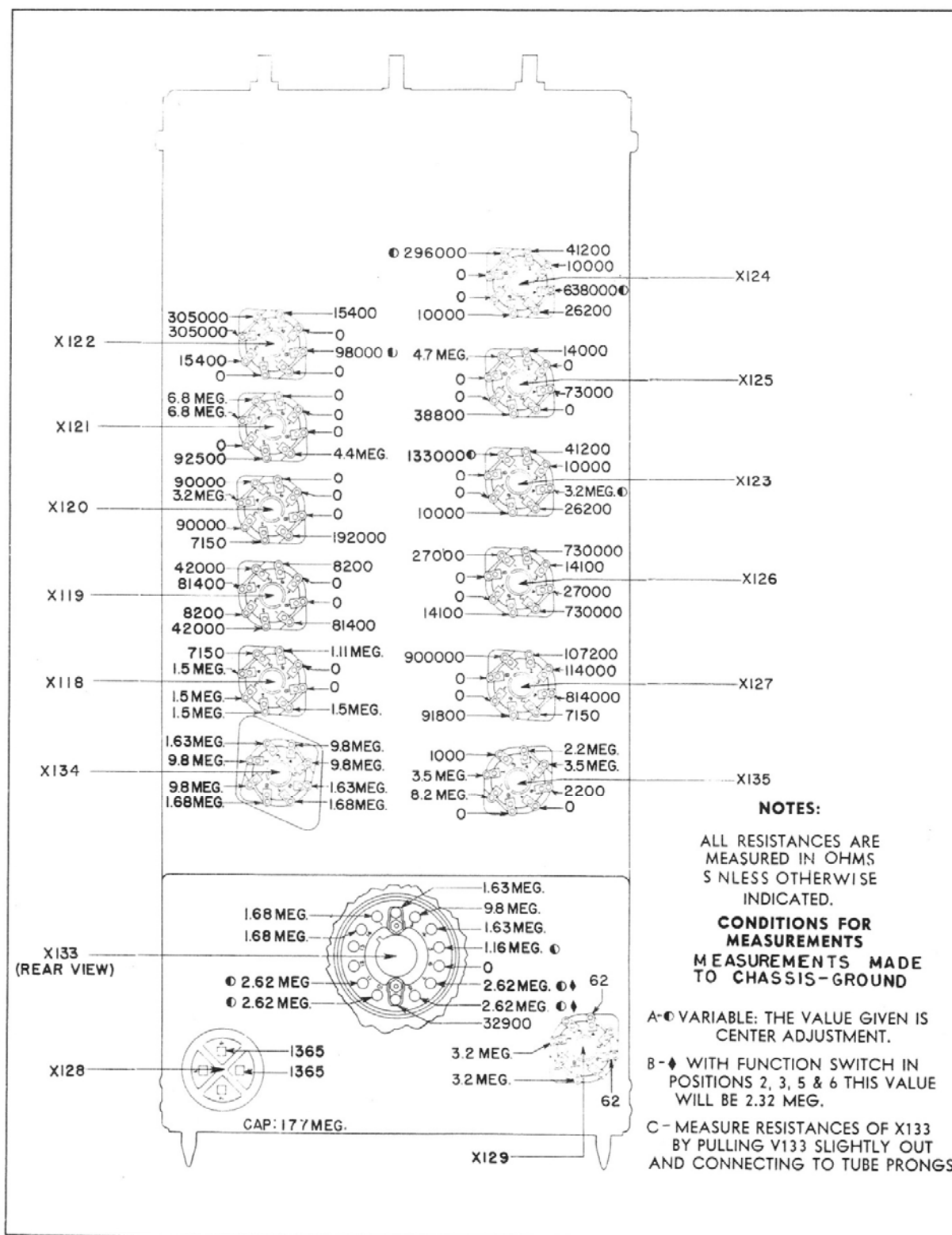


Figure 8-1. Resistance Measurements—Lower Chassis

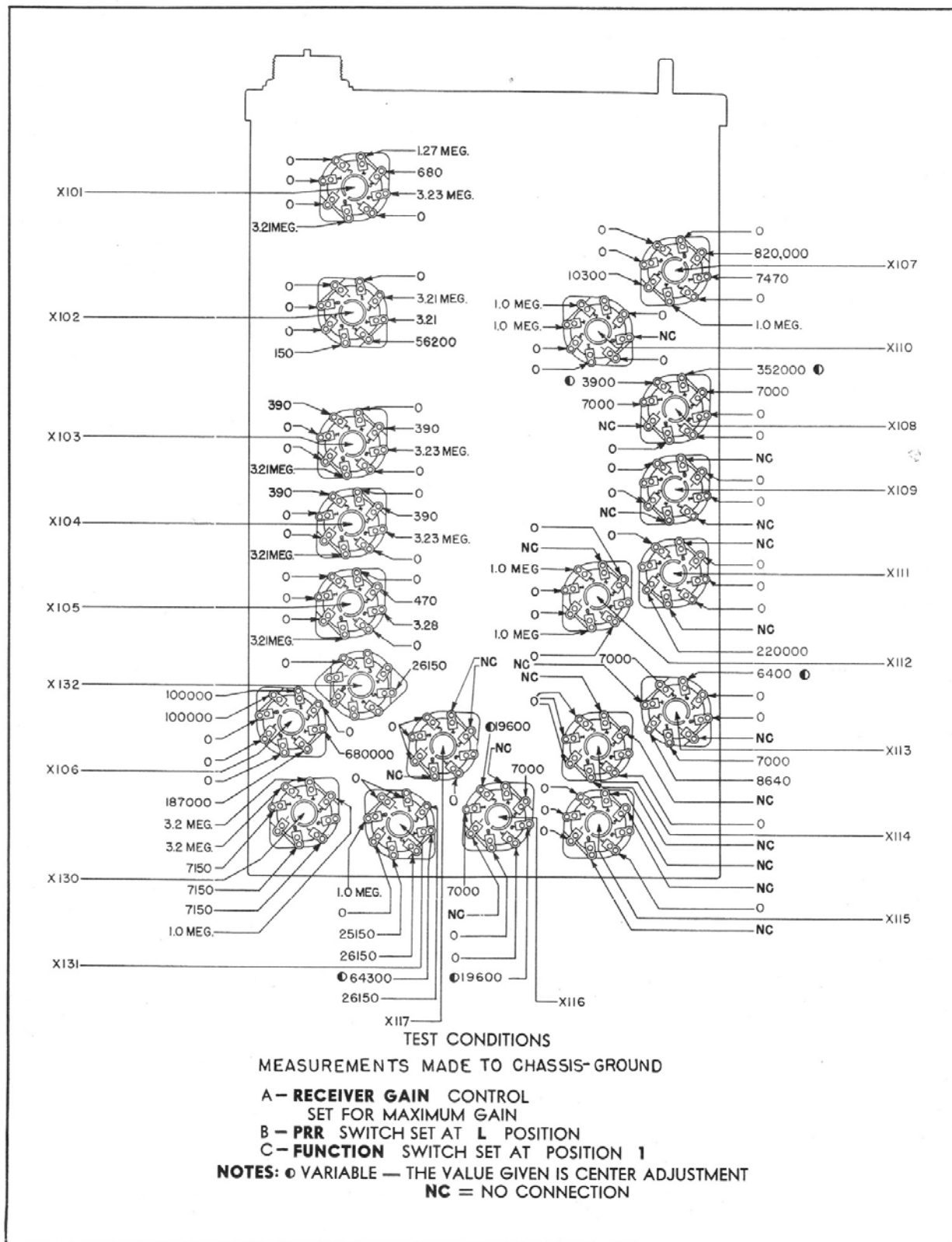


Figure 8-2. Resistance Measurements—Upper Chassis

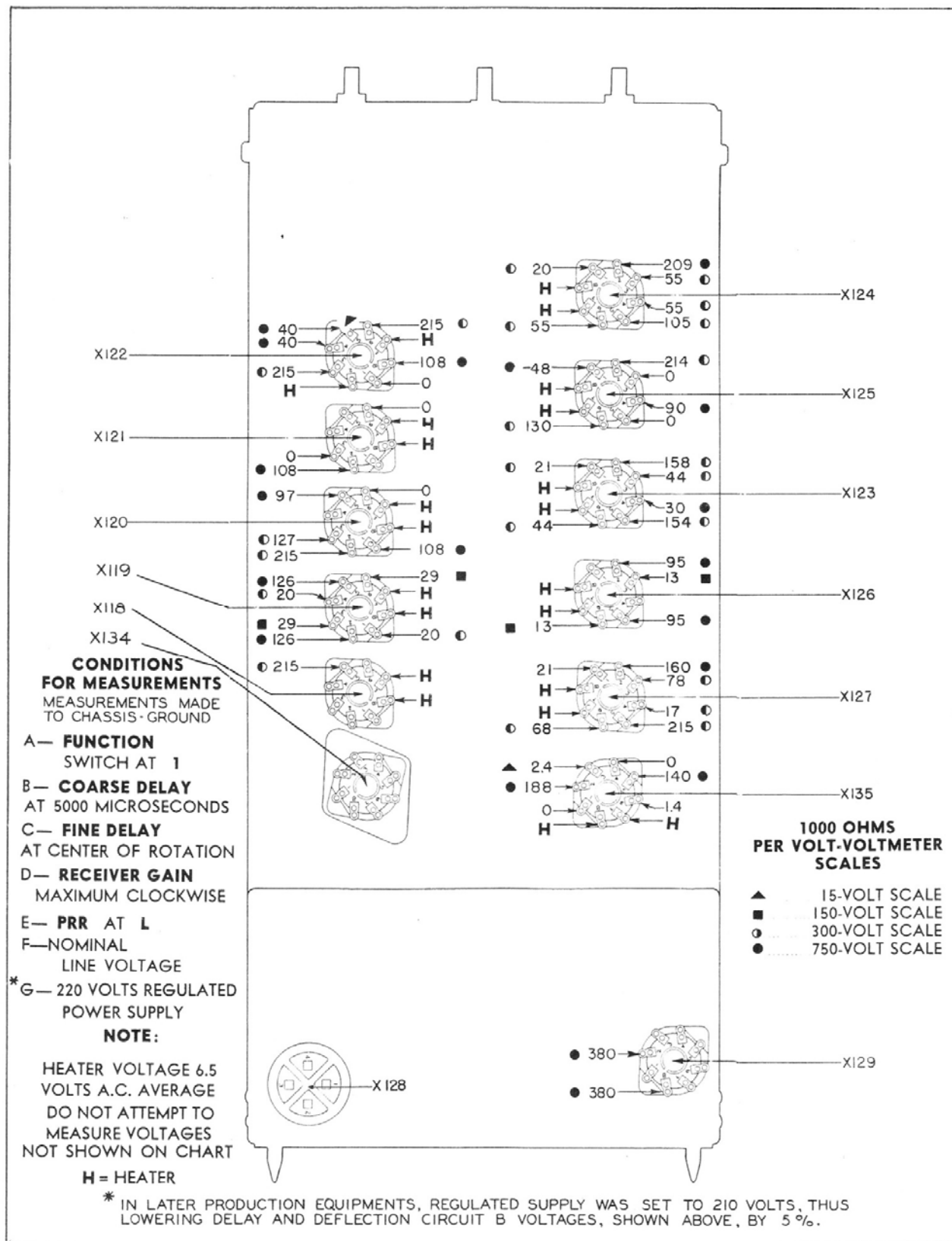


Figure 8-3. Voltage Measurements—Lower Chassis 1000-Ohms Per Volt Voltmeter

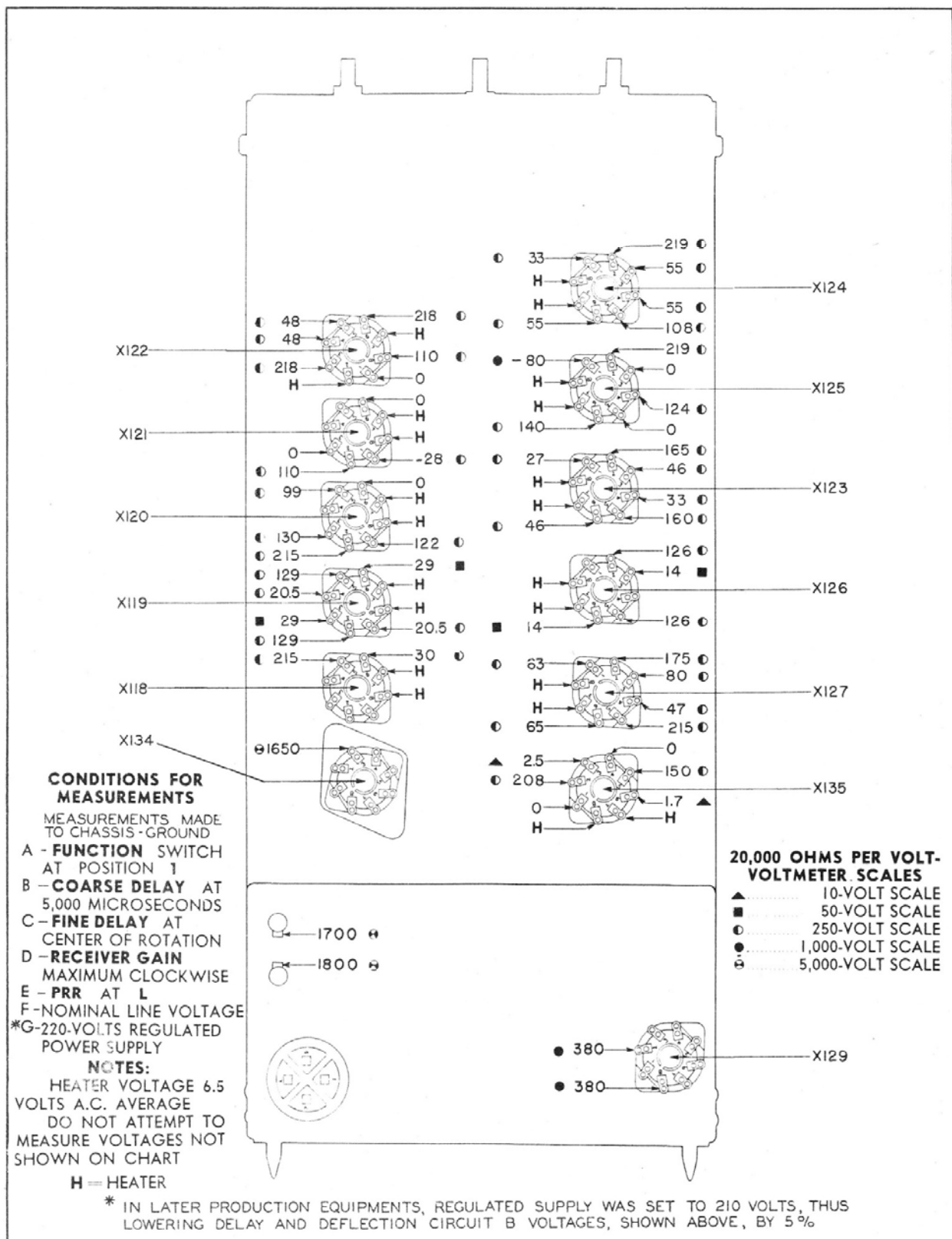
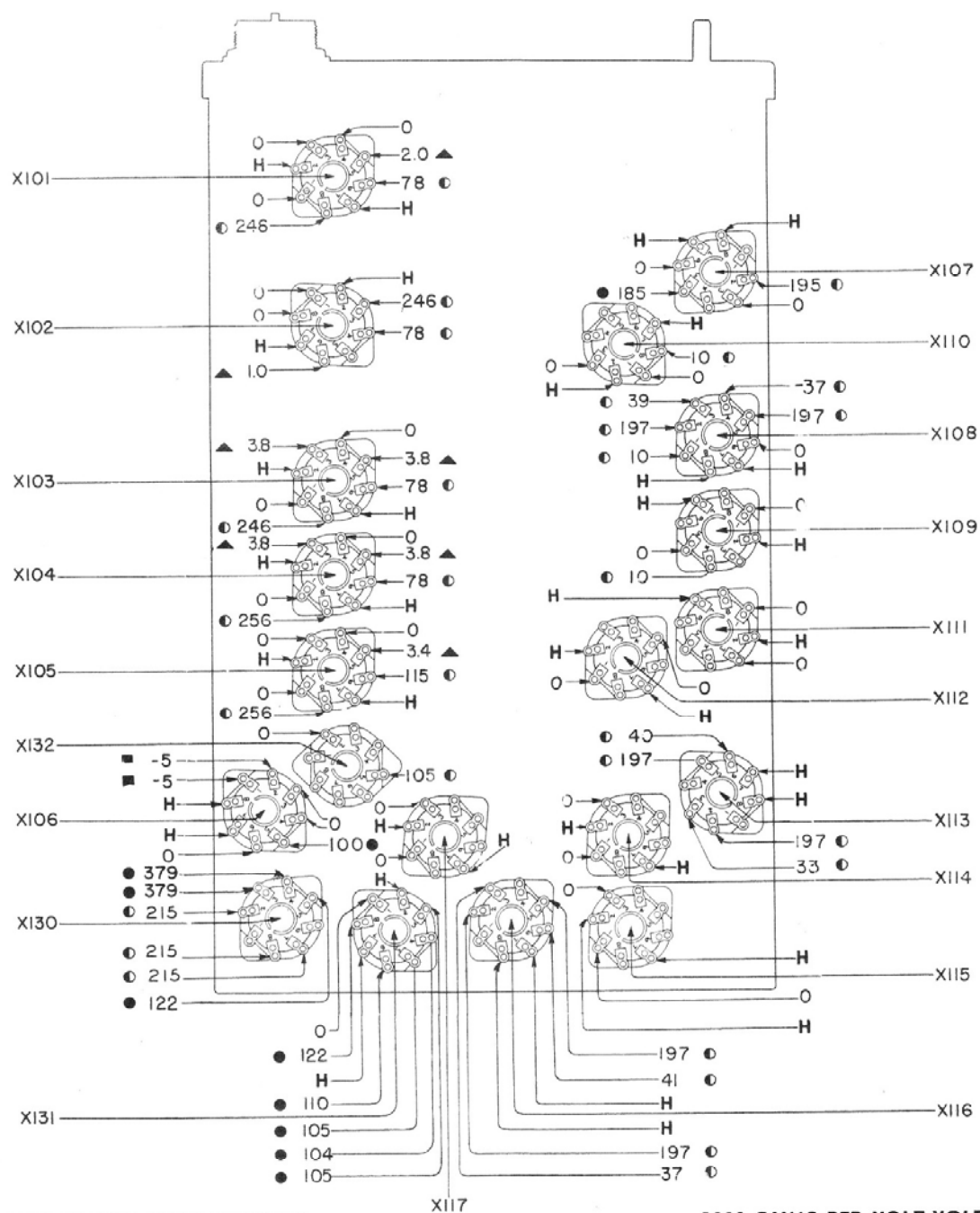


Figure 8-4. Voltage Measurements—Lower Chassis 20,000-Ohms Per Volt Volimeter



CONDITIONS FOR MEASUREMENTS
MEASUREMENTS MADE TO CHASSIS-GROUND
A "FUNCTION" SWITCH — POSITION
B "RECEIVER GAIN" MAXIMUM CLOCKWISE
C "PRR" AT "L"
D 220-VOLT REGULATED POWER SUPPLY (NOMINAL LINE VOLTAGE)

NOTE:

HEATER VOLTAGE 6.5 VOLTS A.C. AVERAGE
DO NOT ATTEMPT TO MEASURE VOLTAGES NOT SHOWN ON CHART
H = HEATER

**1000 OHMS PER VOLT-VOLTMETER
SCALES**

▲ 15-VOLT SCALE
■ 150-VOLT SCALE
○ 300-VOLT SCALE
● 750-VOLT SCALE

Figure 8-5. Voltage Measurements—Upper Chassis 1000-Ohms Per Volt Voltmeter



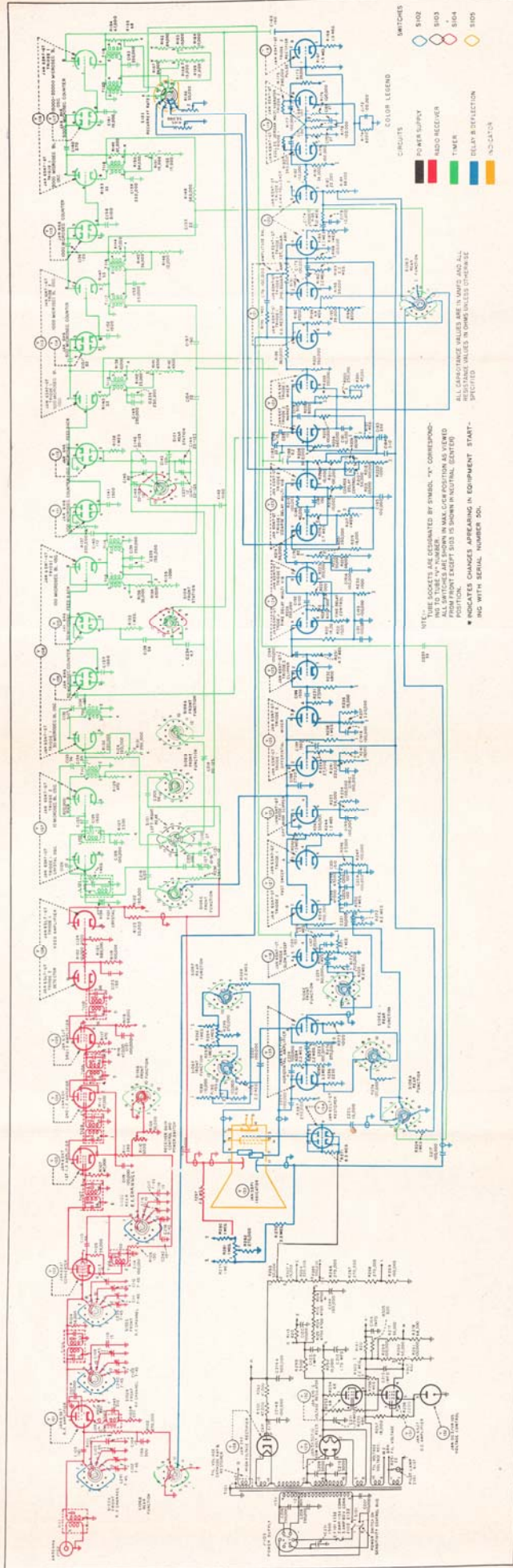
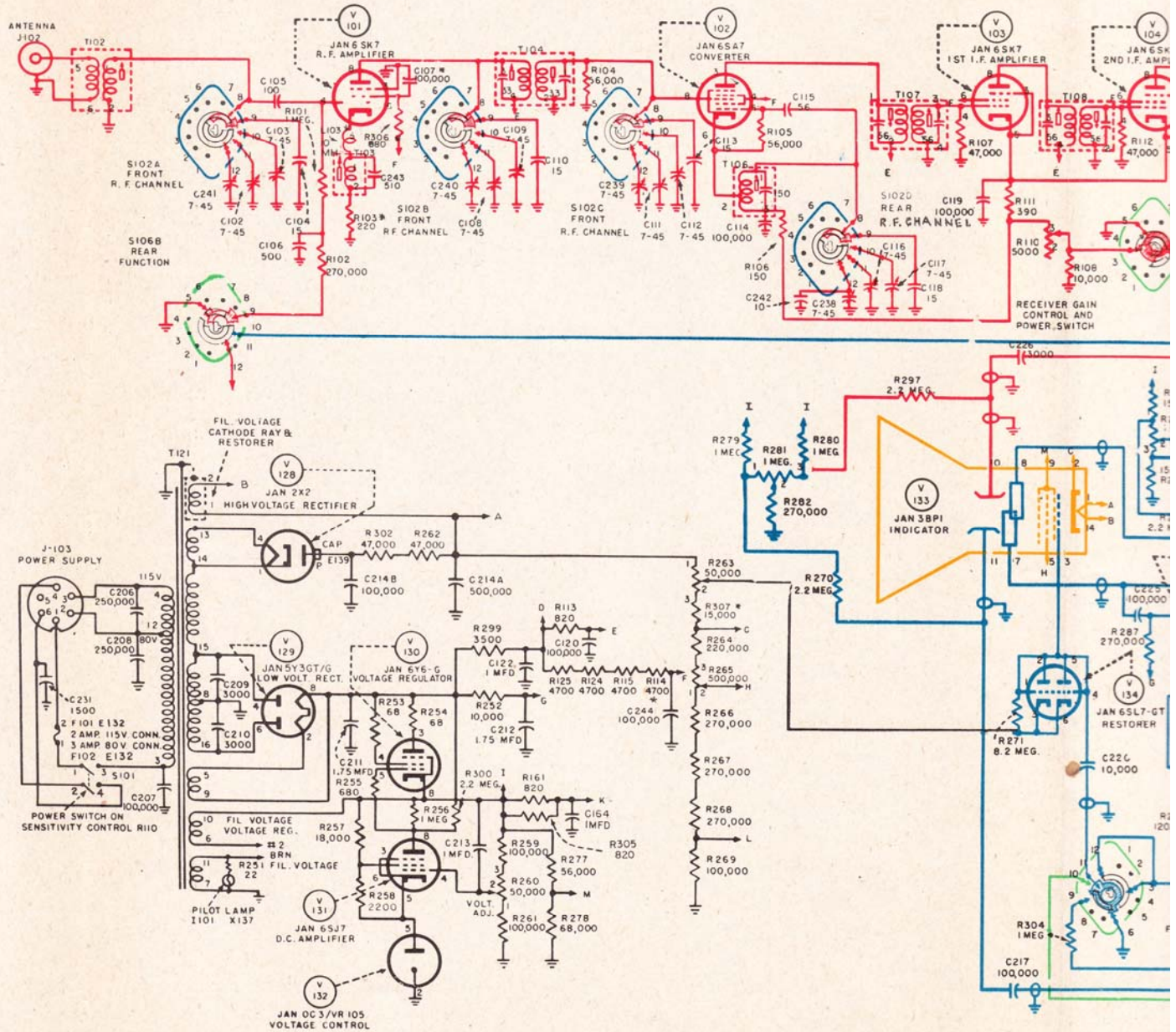
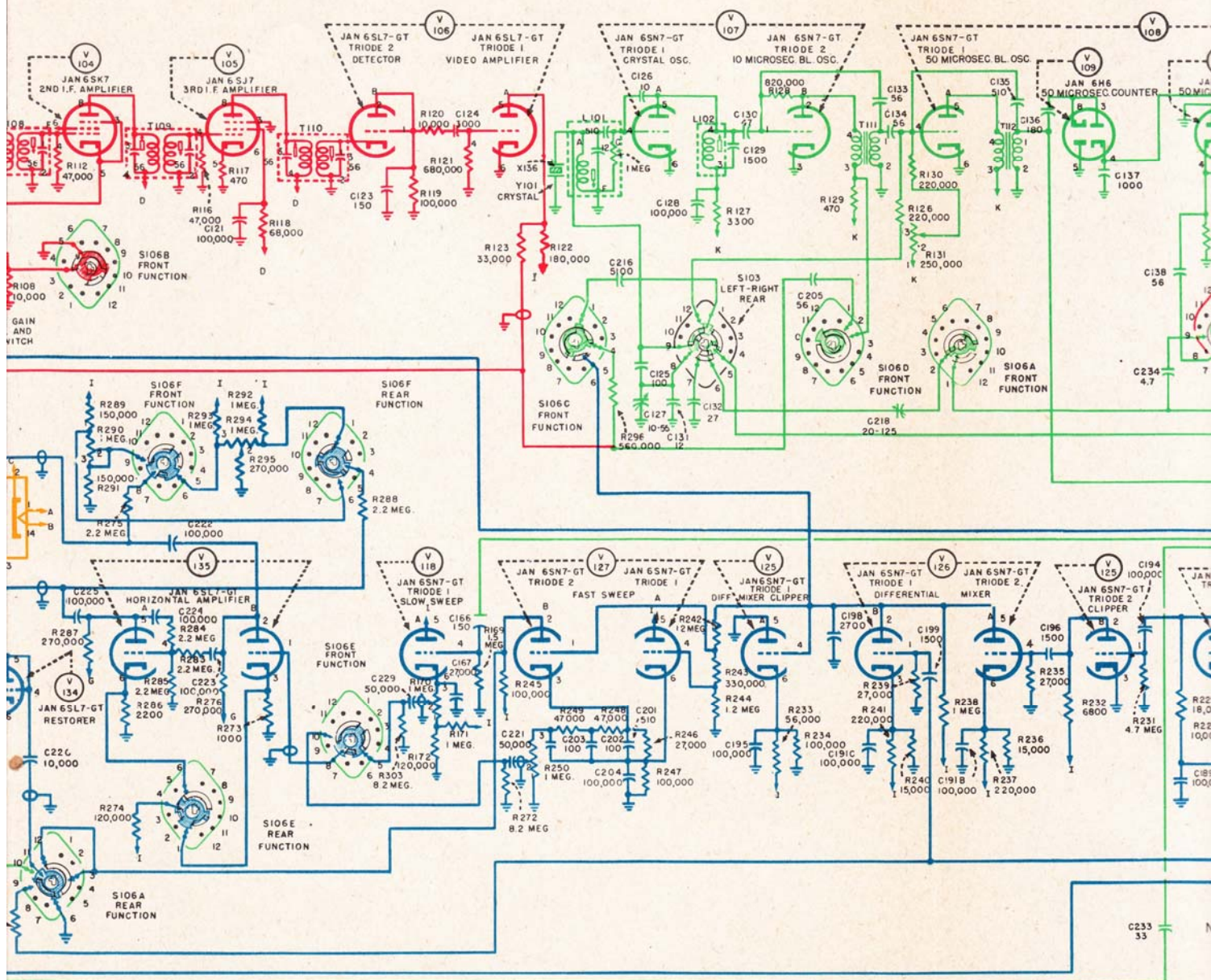


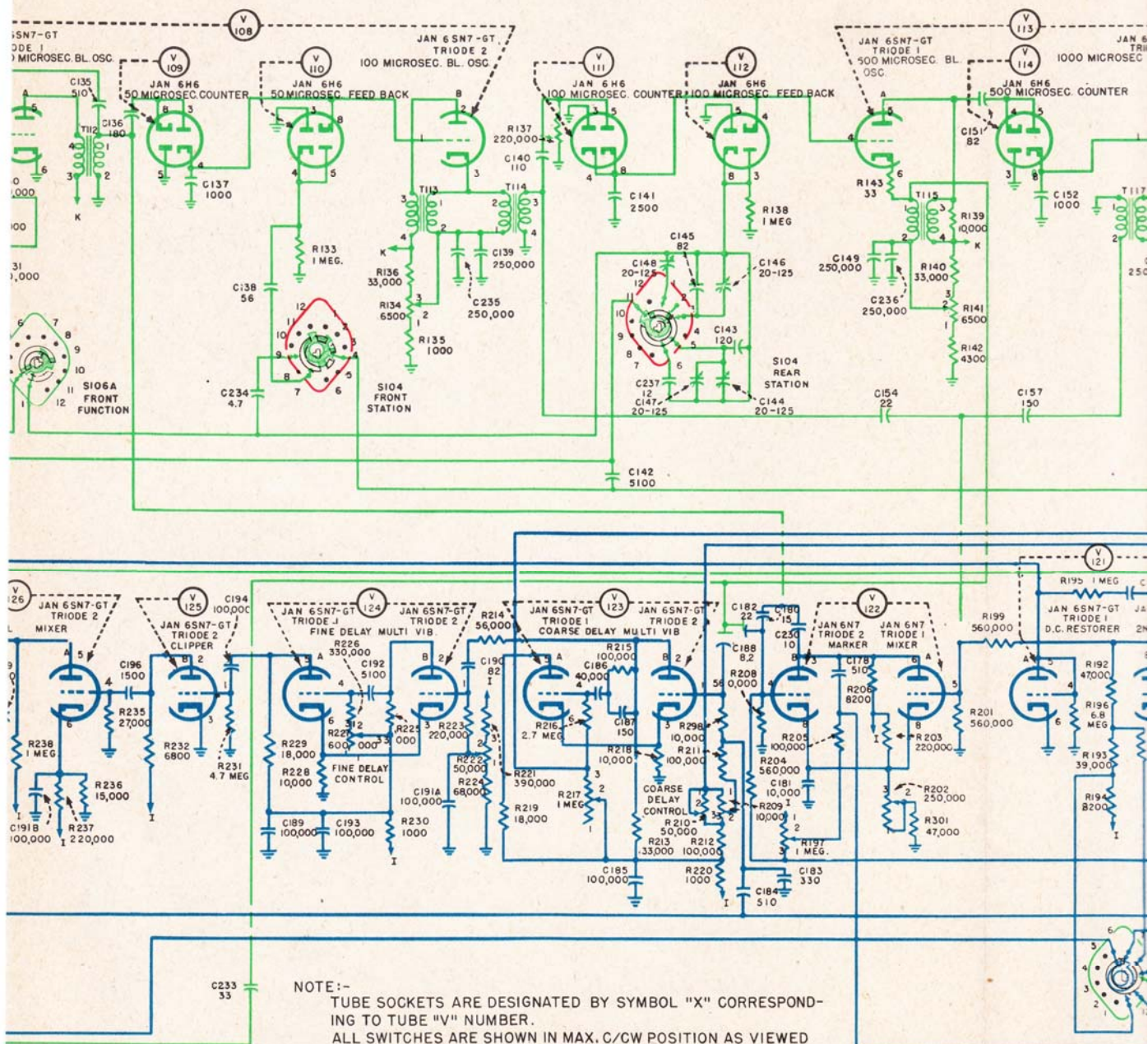
Figure 8-10, Receiver-Indicator 8-45/APN-A—Circuit Diagram

Revised 25 September 1945

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ALL CAPACITANCE VALUES ARE IN MICROFARADS UNLESS SPECIFIED.
RESISTANCE VALUES IN OHMS UNLESS SPECIFIED.

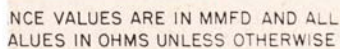


Figure 8-10. Receiver-Indicator R-65/APN-9—Circuit Diagram